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By LOUIS S. KORNICKER

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A STUDY OF THREE SPECIES OF SARSIELLA (OSTRACODA: MYODOCOPA)

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The family Sarsiellidae is represented in the world's oceans between latitudes of 53°N to 47°S (Poulsen, 1965, p. 468). Specimens have been obtained from depths of 2333 m but are more numerous in shallower coastal waters. Members of the family seem better adapted to the shallow inshore environment than other Myodocopa; e.g., sarsiellids were the only myodocopids found in Texas bays and lagoons by Kornicker and Wise (1962) and in San Francisco Bay by Jones (1958a), and only sarsiellids and one other group of myodocopids were reported in the Woods Hole area, Mass., by Cushman (1906). Sarsiellids are benthonic; they swim near the bottom and burrow in sediment. Present evidence indicates that they are carnivores, feeding upon small crustaceans and worms.

The present study has three objectives: (1) to establish more firmly the relationship between *Sarsiella zostericola* Cushman, 1906, *Sarsiella americana* Cushman, 1906, and *Sarsiella tricostata* Jones, 1958; (2) to redescribe *Sarsiella capsula*, the type-species of the genus, which is the type-genus of the family; (3) to determine whether parasitism is the cause of the unusual asymmetry of valves of *Sarsiella disparalis* Darby, 1965, and to ascertain if asymmetry of valves is reflected in appendages.

Abbreviations used in the figures are as follows: ant.=antenna, 1st or 2nd as indicated; bas.=basale; cox.=coxale; e.=edges of valve; end.=endite; exop.=exopodite; i. m.=inner margin of inner lamella; l. p.=lamellar prolongation of selvage; Mn.=mandible; Mx.=maxilla; s.=sensory bristle; 5th=5th limb; 6th=6th limb; numerals=number of each joint in limb; small letter=specific type bristle.

I wish to thank Mr. J. S. Nagle for specimens of *S. zostericola* from Hadley Harbor, Mass., Dr. M. L. Jones for specimens of *S. tricostata* from San Francisco Bay, Calif., Dr. John Day and Miss Mary E. Potts of the Duke University Marine Laboratory for specimens of *S. disparalis* from the Atlantic Shelf off North Carolina, Dr. J. P. Harding and Miss P. D. Lofthouse for assistance in obtaining for examination specimens in the Norman Collection at the British Museum (Natural History), and Dr. Harbans S. Puri for assistance in obtaining for examination specimens collected by G. W. Müller in the Gulf of Naples, which were on loan to Dr. Puri from the Zoological Museum of Greifswald. I also wish to thank Mrs. June M. Gilby for making camera lucida drawings of appendages of *S. capsula* from specimens at the British Museum and Dr. F. M. Swain, who made the arrangements. I also wish to thank Mrs. Carolyne Bartlett Gast and Mr. Leon Connelly for final preparation of plates and figures 9–19, and of figures 3–8, respectively. Criticisms of all or parts of the manuscript by Drs. T. E. Bowman, H. H. Hobbs, Rosalie F. Maddocks, R. B. Manning, and I. G. Sohn are deeply appreciated. Finally I wish to thank Dr. Robert V. Kesling for the opportunity to examine the holotype (UMMP 48819) and a paratype (UMMP 48818) of *S. disparalis* Darby.

Family Sarsiellidae Brady and Norman, 1896

When Poulsen (1965, p. 44) revised the family Sarsiellidae, he recognized the following genera: *Sarsiella* Norman, 1869; *Chelicopia* Kornicker, 1959; *Eusarsiella* Poulsen, 1965; *Scottiella* Poulsen, 1965; *Muelleriella* Poulsen, 1965; *Parasarsiella* Poulsen, 1965.

He also (1965, p. 74) included the following species in *Sarsiella:* *S. capsula* Norman, 1869; *S. rugosa* Poulsen, 1965; *S. carinata* Scott, 1905, sensu Kornicker, 1959 (male only).

In his "Key to Genera of Sarsiella," Poulsen (1965, p. 55) separated *Sarsiella* from *Scottiella*, *Muelleriella*, *Chelicopia*, and *Parasarsiella* on the basis of characters common to both sexes, but he separated *Sarsiella* from *Eusarsiella* on the basis of a male character:

Endopodite of male 2nd antenna an unjointed bulge . . . . . **Sarsiella**
Endopodite of male 2nd antenna 3-jointed, prehensile . . . . . **Eusarsiella**

Among the species included in *Sarsiella* sensu Poulsen, the female is known only for *S. capsula* Norman. The lengths of claws and

bristles of the mandible, and the relative lengths of parts of the mandible to shell length of the female *S. capsula* are compared to females of other sarsiellids by Poulsen (1965, pp. 76, 147, table 4). Although the relative lengths of claws, bristles, and joints of the mandible of *S. capsula* are somewhat different from other sarsiellids, the value of these characters for distinguishing *Sarsiella* from other genera is diminished because the variability of the measured characters among females of *Sarsiella* is unknown.

In his diagnosis of *Sarsiella*, Poulsen stated (1965, p. 76) that the distal bulge of the ventral margin of the coxale of the mandible of the female does not have a fringe of hairs. This observation must have been based on the description and illustration of the mandible of *S. capsula* by Müller (1894) because neither Norman (1869) nor Brady and Norman (1896) described the coxale and the specimen of *S. capsula* illustrated by Sars (1888, pl. X: fig. 4) has a fringe of hairs along the ventral margin of the mandibular coxale. I examined the mandible of a specimen from the Gulf of Naples that had been identified by Müller as *S. capsula* Norman and found that, contrary to Müller's description, the ventral margin of the mandibular coxale is fringed with hair. Lack of hairs on the coxale would have been a useful criterion for separating the female *Sarsiella* from *Eusarsiella*, which does have hairs.

I have been unable to find satisfactory morphological characters for separating females of *Sarsiella* from *Eusarsiella*. Males of the Sarsiellidae are relatively sparse compared to females and are unknown for many species. I believe, therefore, that it is premature to separate *Eusarsiella* from *Sarsiella* until it is possible to do so on the basis of females or until males of more species become known.

Only Müller (1894) identified and described males of *S. capsula*. It was, therefore, on the basis of Müller's specimens that Poulsen (1965) retained the generic name *Sarsiella* for species with an unjointed bulge forming the endopodite of the male 2nd antenna and referred to *Eusarsiella* the remaining species with a 3-jointed endopodite. As discussed on page 33, Müller erred in his identification of *S. capsula*, and the endopodite of the male 2nd antenna of *S. capsula* Norman is actually 3-jointed. According to this criterion, the type-species of *Sarsiella* would belong in the genus *Eusarsiella*. *Eusarsiella*, therefore, should be considered a synonym of *Sarsiella*.

Sarsiella Norman, 1869

Sarsiella Norman, 1869, p. 293.
Nematohamma Brady and Norman, 1896, p. 680.
Eusarsiella Poulsen, 1965, p. 79.

Type-species by monotypy: *S. capsula* Norman, 1869.

Diagnosis.—Sarsiellid having furca without secondary claws and

with 5 (rarely 6) main claws of which only claw no. 1 is united with lamella. Sixth limb with only 1 endite. Male mandible with exopodite. Endopodite of 2nd antenna of male with 1 or, more usually, 3 joints. Inner margin of "clasper" of male copulatory limb either smooth or serrated. Shell of adult male with rostrum and shallow sinus; shell of female generally without rostrum or sinus.

Sarsiella zostericola Cushman, 1906

FIGURES 1–15; PLATES 1, 2

Sarsiella zostericola Cushman, 1906, pp. 364–366, pl. 28 (figs. 7–18).—Blake, 1933, p. 230 [listed].—Kornicker and Wise, 1962, p. 61, figs. 2 A–G, 4 A–C.
Sarsiella americana Cushman, 1906, pp. 363, 364, pl. 27 (figs. 1–6).
Sarsiella tricostata Jones, 1958a, pp. 48–52, figs. 1, 2; 1958b, figs. 1–3; 1961, pp. 261, 262, figs. 20, 28, table 19 [listed].
Eusarsiella zostericola Cushman-Poulsen, 1965, p. 83 [in key].
Eusarsiella americana Cushman-Poulsen, 1965, p. 83 [in key].

Lectotype: USNM 113357, male whole specimen preserved dry. Cushman (1906) did not designate a holotype; however, one slide in his collection is marked "type." The specimen on this slide is herein designated lectotype.

Paralectotypes: USNM 113358, 1 male and 2 juveniles, whole specimens preserved dry. These specimens are in a slide in the Cushman Collection marked "co-types." These specimens are designated paralectotypes herein.

Sarsiella zostericola was established by Cushman (1906, p. 364) to receive numerous specimens collected from the "Gulf of Canso," a channel near Woods Hole, Mass. In the same paper, Cushman based a second species, *S. americana*, on a single specimen collected in the western part of Vineyard Sound, Mass. Blake (1933) extended the range of *S. zostericola* to the Mount Desert region of Maine, but neither illustrated nor described the specimens. Jones (1958a) collected from San Francisco Bay, Calif., ostracods that closely resembled *S. zostericola* but differed sufficiently from the description of *S. zostericola* to warrant his establishing the new species *S. tricostata*. Kornicker and Wise (1962) extended the range of *S. zostericola* to southwest Texas, where the species was collected in bays and lagoons along the coast bordering the Gulf of Mexico. After examining the carapace of the specimen of *S. americana* described by Cushman (1906), Kornicker and Wise (1962) reported it identical to that of *S. zostericola*, and concluded that apparent differences are due to the carapace of *S. americana* having been distorted after death of the animal. They also concluded that "differences in appendages

[of *S. zostericola* and *S. americana*] reported by Cushman (1906) may partly be the result of individual variation, or possibly the result of comparing animals not of the same age," and, therefore, they considered *S. americana* to be a junior synonym of *S. zostericola*. Because some of the differences between *S. zostericola* and *S. tricostata* disappear when *S. zostericola* and *S. americana* are considered to be conspecific and because some of Cushman's observations are obviously in error, Kornicker and Wise (1962) considered *S. tricostata* also to be a junior synonym of *S. zostericola*.

The present study of the ontogeny of *S. zostericola* shows that the pre-adult female bears 2 ventral bristles on the 4th joint of the 1st antenna, compared to 3 on the adult, and has the caudal process of the carapace more posteriorly located than on the adult. The female *S. zostericola* described by Cushman (1906, p. 365, pl. 28: figs. 15, 16) bears only 2 bristles on the 4th joint of the 1st antenna, and the caudal process is posterior, indicating that it is a pre-adult female.

Since appendages of the holotype of *S. americana* are not available, it is necessary to rely on the original description of the species in which Cushman (1906) illustrated the 1st antenna (pl. 27: fig. 3), the exopodite of the 2nd antenna (pl. 27: fig. 4), the caudal lamellae (pl. 27: fig. 6), and the mandible (pl. 27: fig. 5). Cushman reported only 5 bristles on the end joints of the 1st antenna. As other sarsiellids have 9 bristles on the end joints (5th–8th), it seems likely that some bristles were overlooked by Cushman. Cushman reported only 1 seta on the ventral margin of the basale of the mandible of *S. americana*, whereas *S. zostericola* has 5. The caudal lamellae and the exopodites of the 2nd antenna of *S. americana* and *S. zostericola* are similar.

Except for a possible difference in the number of bristles on the ventral margin of the mandibular basale, *S. zostericola* and *S. americana* seem identical and, therefore, I concur with Kornicker and Wise (1962) in considering *S. americana* a synonym of *S. zostericola*.

I have compared the shells and appendages of adult specimens from Massachusetts (*S. zostericola*) and California (*S. tricostata*) and I find that the 2 populations cannot be distinguished, which confirms the conclusion of Kornicker and Wise (1962) that *S. tricostata* and *S. zostericola* are conspecific. Specimens of *S. zostericola* from Texas could not be distinguished from those from Massachusetts and California, and I can find no evidence of subspeciation in this ostracod.

Because of the presence of instars in the collection from California, it has been possible to study the ontogenetic development of the species and to describe instars as well as the adults.

MATERIAL.—The number, source, and collection data for the specimens examined during this study are as follows:

USNM	*number of specimens*	*locality*	*date collected*	*remarks*
113357	1 adult ♂ dried	Gulf of Canso, Woods Hole, Mass.	Aug. 3, 1905	lectotype
113358	1 adult ♂ 2 juveniles, all dried	Gulf of Canso, Woods Hole, Mass.	Aug. 3, 1905	paralectotypes
113356	1 adult ♀ consisting of dried left and right valves	Vineyard Sound, Mass. Fish Hawk Sta. 7723		identified as *Sarsiella americana* Cushman by J. S. Cushman; slide is marked "Type"
100903	1 adult ♀ in alcohol	Pt. Richmond, San Francisco Bay, Calif.	July 14, 1957	holotype of *Sarsiella tricostata* Jones
107847	1 adult ♂ consisting of dried left and right valves	Redfish Bay, Tex.	1958	specimen illustrated by Kornicker and Wise (1962, figs. 2A–B)
107848	1 adult ♀ dried	Port Isabel, Tex.	1958	
113461	11 adult ♀ ♀ 1 adult ♂ 1 juvenile in alcohol	Port Isabel, Tex.	1958–1960	
113462	6 adult ♀ ♀ 5 adult ♂ ♂ 17 juveniles in alcohol	Pt. Richmond, San Francisco Bay, Calif.	1955–1956	
113463	84 adult ♀ ♀ in alcohol	Hadley Harbor, Mass. Sta. P. 1907	1965	
113508	2 juveniles	Hadley Harbor, Mass. Sta. P. 242	1965	
113509	1 adult ♂ 4 juveniles in alcohol	Hadley Harbor, Mass. Sta. P. 264.25	1965	
113510	2 juveniles in alcohol	Hadley Harbor, Mass. Sta. P. 264.50	1965	

When the lengths of shells of females in the collection are plotted as a function of shell height, the points form 4 discrete clusters representing 4 developmental stages (fig. 1). As seen in figure 1, considerable space exists between the smallest instar and embryos obtained from the brood chamber of a gravid female. The space is interpreted as showing that 1 or more of the younger female instars are missing from the collection. By using Przibram's growth factor of 1.26, which predicts the theoretical difference of a linear dimension in 2 consecutive

molts (Przibram, 1931, p. 21), it is possible to conclude that instars I and II are missing from the collection. The conclusion, however, must be considered tentative because of the many factors that cause the growth rate to deviate from the theoretical (Teissier, 1960, p. 541). Males of instars I and II are also missing from the collection. Lateral outlines of shells at stages of development present in the collection are illustrated in figure 2. Average dimensions at each growth and calculated growth factors of females from California are tabulated as follows:

growth stage	*average length (mm)*	*growth factor*	*average height (mm)*	*growth factor*
adult	1.24		1.11	
		1.34		1.41
V	0.92		0.79	
		1.33		1.33
IV	0.69		0.59	
		1.23		1.29
III	0.56		0.46	
		1.26[a]		1.26[a]
II (missing)	0.44[b]		0.36[b]	
		1.26[a]		1.26[a]
I (missing)	0.35[b]		0.29[b]	
embryo (from Mass.)	0.32		0.26	

[a] Przibram's theoretical growth factor for a linear dimension.
[b] Calculated dimensions estimated by dividing Przibram's factor (1.26) into dimension of succeeding growth stage.

In several collections off Point Richmond, Calif., Jones (1961, figs. 20d–g) obtained a total of about 240 adult females and 36 adult males; adult females outnumbered adult males by 6 or 7 to 1. In the present study juveniles were picked at random from available collections from Point Richmond. The numbers are too few to determine accurate ratios; however, females outnumbered males in all molt stages:

developmental stage	*no. of females*	*no. of males*
III	4	1
IV	5	1
V	4	2

Description of adult female.—Shell (figs. 3*a*, *b*; 4; 5*a–d*; pl. 1): dorsal view with broadly rounded posterior and acuminate anterior (fig. 3*b*); oval in lateral view except for posteroventral caudal process (figs. 3*a*, 4*a*). Surface ornamented with punctae and 3 raised ribs radiating from hub slightly forward of center of valve; posterior rib terminating in knob with 2 small lateral pits; velate ridge parallel to edge of valves; shell broadest at hub of radial ribs or at pitted

knob of posterior ridge; valve surface with scattered hairs; valve margins with rows of long hairs faintly annulated proximally (figs. 4*a*, *b*).

Adductor muscle scars consisting of clusters of ovate scars near junction of radial ribs (fig. 4*e*); several ovate dorsal muscle scars occurring below anterior termination of hinge; false radial canals numerous, each with long bristle (fig. 4*b*); normal pore canals sparsely distributed over valve surface.

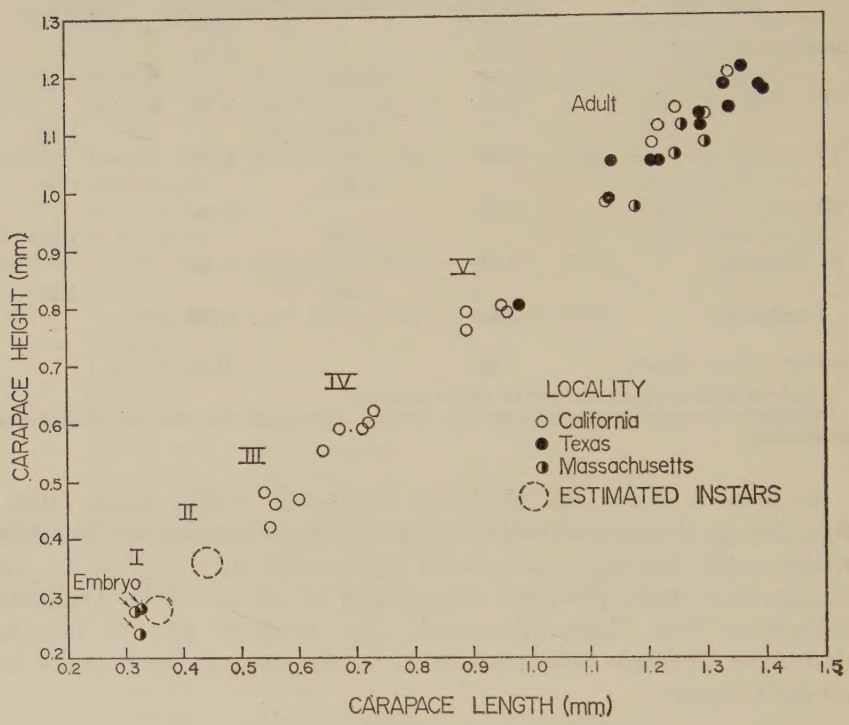

FIGURE 1.—*Sarsiella zostericola* Cushman: relationship between shell length and height of female.

Duplicature broad except dorsally; 1 or 2 small bare medial bristles along anterior part (figs. 4*a–e*), 1 long and 2–6 short bristles medially on caudal process, long bristle posterior to shorter bristles, all bristles bare (figs. 4*f–j*; 5*a–d*); 2–3 small bare bristles near inner margin of duplicature dorsal to caudal process followed by 2 long hirsute bristles near outer margin (figs. 4*g*; 5*c*); 1–3 short bare bristles near inner margin of duplicature anterior to caudal process and posterior to a cluster of 3 bare bristles (figs. 4*g*; 5*c*). Selvage narrow with trans-

verse striations and extending outward in unstriated lamellar prolongation with fine marginal fringe along anterior and posterior parts on some specimens (figs. 4*c*, *g*). Hinge simple, occupying posterior two-thirds of dorsal margins (fig. 4*a*) and connected by ligament (pl. 1*a*, *b*).

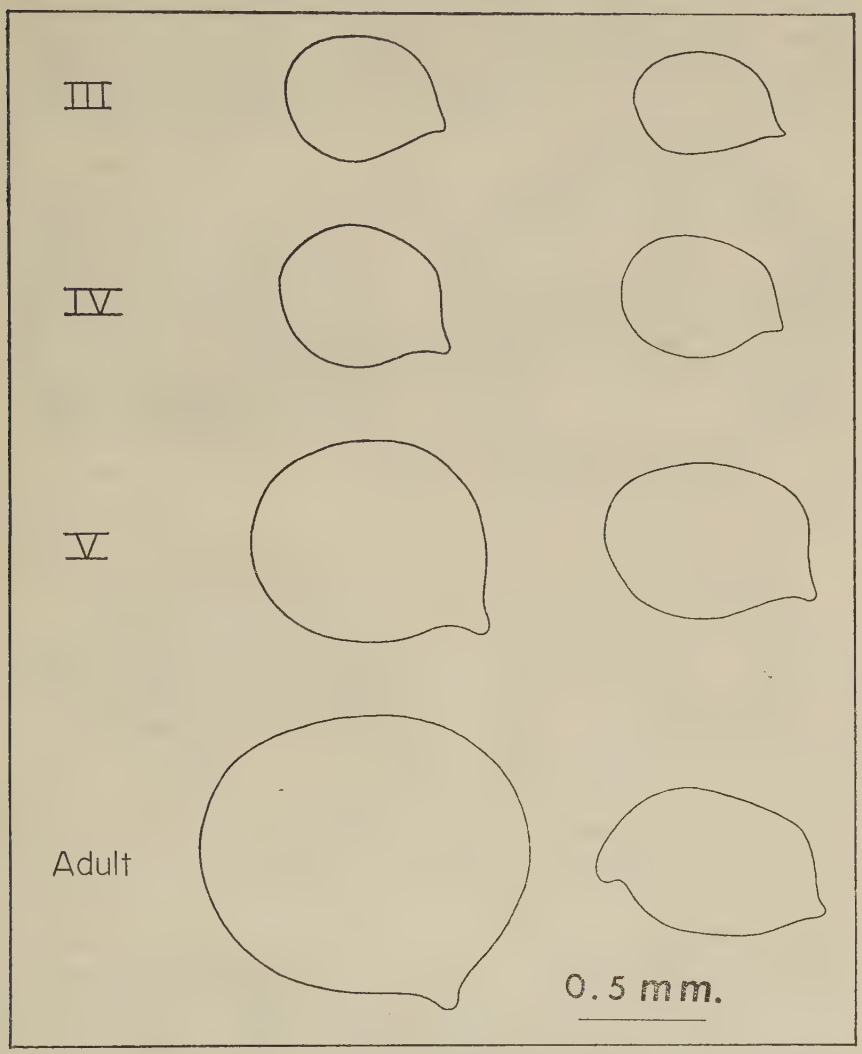

FIGURE 2.—*Sarsiella zostericola* Cushman: comparison of lateral outlines of instars III–V and adults (females on left, males on right).

Outer lamella of valve laminated (pl. 1*c–f*); duplicature in x-section appearing as fold in inner part of outer lamella (pl. 1*d*); marginal ridge (pl. 1*d*) and medial ridge (pl. 1*e*) in x-section appearing as fold in outer part of outer lamella. Clusters of dorsally oriented spines

occupying middle ventral area within inner margin of inner lamella (fig. 4*d*).

The carapace of *S. americana* illustrated by Cushman (1906, pl. 27: fig. 1) is labeled: "Shell of female seen from the side." This illustration shows the left valve. It has been interpreted as the right valve by Poulsen (1965), who, in his "Key to the Species of the Genus *Eusarsiella*," distinguishes *americana* from *zostericola* by the former having a few irregular teeth along the anteroventral margin of the shell.

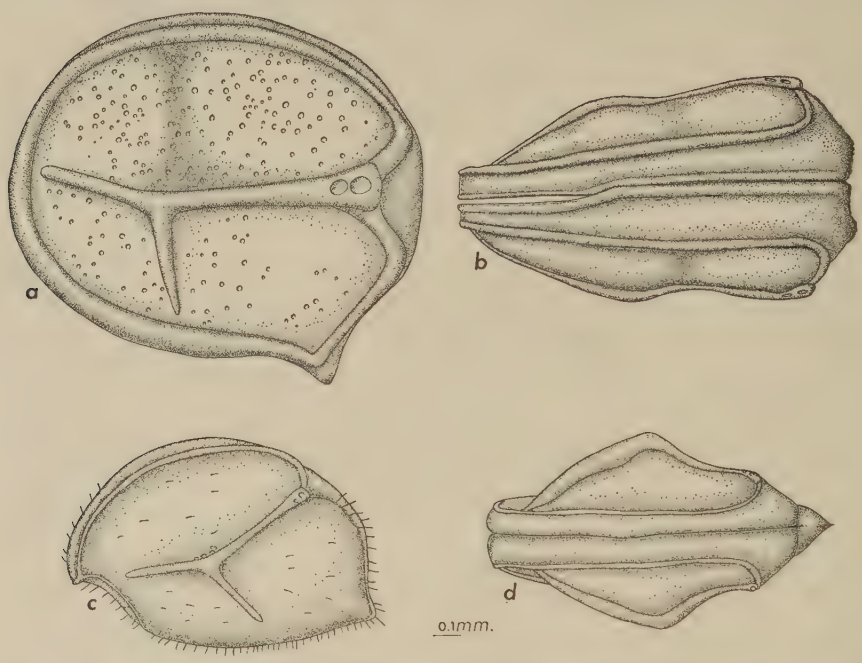

FIGURE 3.—*Sarsiella zostericola* Cushman, Hadley Harbor, Mass., adult ♀, sta. P. 1907, 1.25 mm: *a*, left lateral view; *b*, dorsal view, anterior to left. Adult ♂, sta. P. 264.25, 1.01 mm: *c*, left lateral view; *d*, dorsal view, anterior to left.

The "teeth" described as spines by Cushman (1906, p. 363) are actually along the posterodorsal margin. The illustration of Cushman (pl. 27: fig. 1) does, in fact, look more like a right than left valve because the valve is higher than it is long. This indicates that the drawing is of a distorted valve because Cushman (1906, p. 363) states that the length of the shell is very slightly greater than the height.

Mean lengths of selected adult females from San Francisco, Calif., Hadley Harbor, Mass., and Port Isabel, Tex., are 1.23 mm (N=17), 1.24 mm (N=8) and 1.28 (N=11), respectively. These means do not

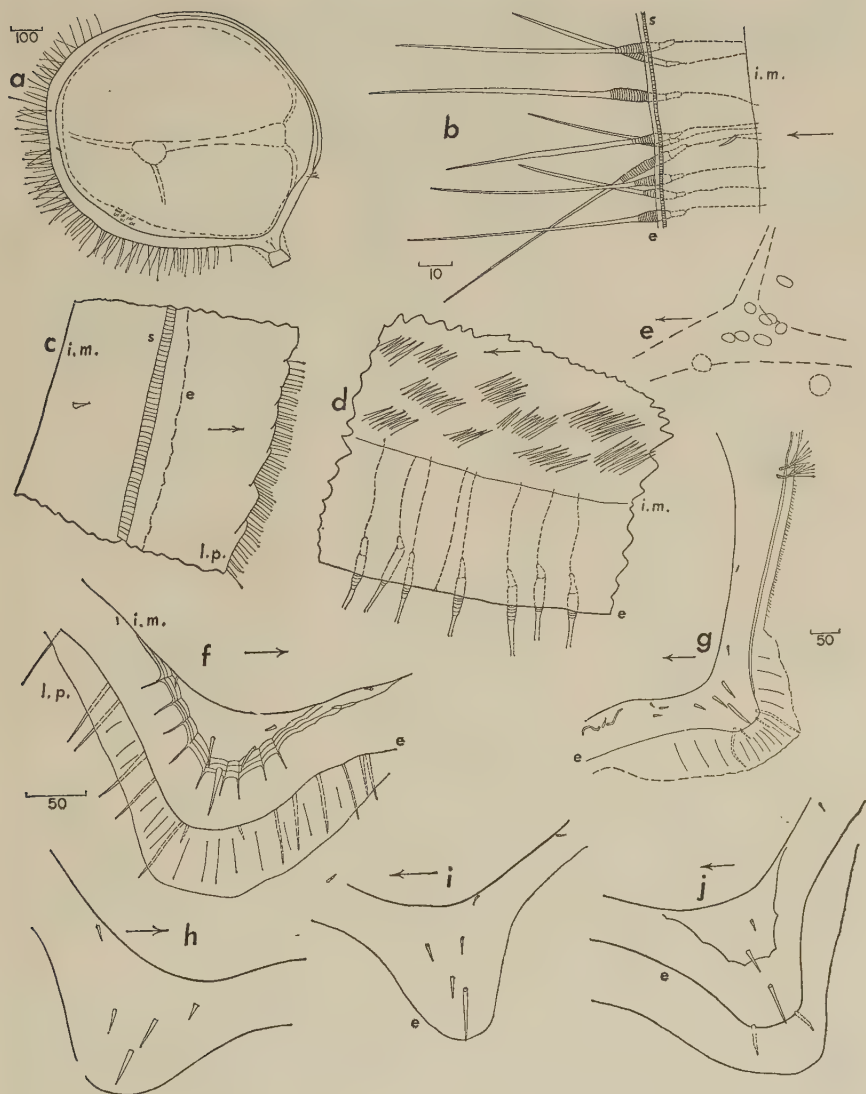

FIGURE 4.—*Sarsiella zostericola* Cushman, Hadley Harbor, Mass., ♀, 1.26 mm: *a*, medial view right valve (broken circle encloses muscle scars); *b*, anterior part of right valve showing small bristle on inner lamella and marginal bristles; *c*, anterior part of left valve; *d*, ventral part of right valve showing clusters of spines; *e*, muscle scar area of left valve; *f*, caudal process of left valve; *g*, caudal process and posterior margin of right valve. Female, 1.30 mm: *h*, caudal process of left valve. Female, 1.25 mm: *i*, caudal process of right valve. Female, 1.30 mm: *j*, caudal process of right valve. (Lamellar prolongation not shown in *b*, *h*, *i*; same scale in microns: *a*; *b–d*; *e*, *g*; *f*, *h–j*.)

differ significantly at the 95 percent level of probability. Dimensions of representative specimens are as follows:

locality	*midlength (mm)*	*midheight (mm) (excluding caudal process)*	*remarks*
San Francisco, Calif.	1.30	1.13	11 eggs in brood chamber
" "	1.34	1.20	10 " " " "
" "	1.25	1.14	well-developed eggs
" "	1.22	1.11	6 well-developed eggs within body
" "	1.21	1.08	no eggs in brood chamber
" "	1.13	0.98	eggs in brood chamber
Port Isabel, Tex.	1.13	0.98	5 eggs in brood chamber
"	1.14	1.05	6 " " " "
"	1.39	1.18	no " " " "
"	1.34	1.14	" " " " "
"	1.22	1.05	" " " " "
"	1.36	1.21	14 " " " "
"	1.21	1.05	5 " " " "
"	1.40	1.17	5 " " " "
"	1.29	1.11	no " " " "
"	1.33	1.18	7 " " " "
"	1.29	1.13	7 " " " "
Hadley Harbor, Mass.	1.26	1.11	eggs in brood chamber
" "	1.25	1.06	" " " "
" "	1.30	1.08	" " " "
" "	1.18	0.97	8 embryos in brood chamber

The number of medial bristles on the caudal process were found to vary considerably among specimens from the same locality and, indeed, on opposite valves of the same specimen. In general, the Atlantic and Pacific specimens are similar, each having a long posterior and several smaller anterior bristles.

First antenna (figs. 5*e*, *f*): 1st joint bare; 2nd joint with 1 spinous dorsal bristle and 2 groups of short spines along dorsal margin; 3rd joint with 1 dorsal bristle and without suture separating it from 4th joint; 4th joint with 1 spinous dorsal bristle, 1 short and 2 long ventral bristles, and 2 groups of short spines along ventral margin; 5th joint with stout sensory bristle; 6th joint with short spinous, medial bristle; 7th joint with medium a- and b-bristles and long c-bristle; 8th joint with d-, e-, f-, and g-bristles about same length as sensory bristle on 5th joint.

The 1st antenna of *S. zostericola* is described by Cushman (1906, pl. 28: fig. 16) as having only 1 long and 1 short ventral bristle on the 4th joint because Cushman described a juvenile specimen. Cushman's description of the 1st antenna of *S. americana* (1906, p. 363, pl. 27: fig. 3) shows it to be similar to adult specimens of *S. zostericola*.

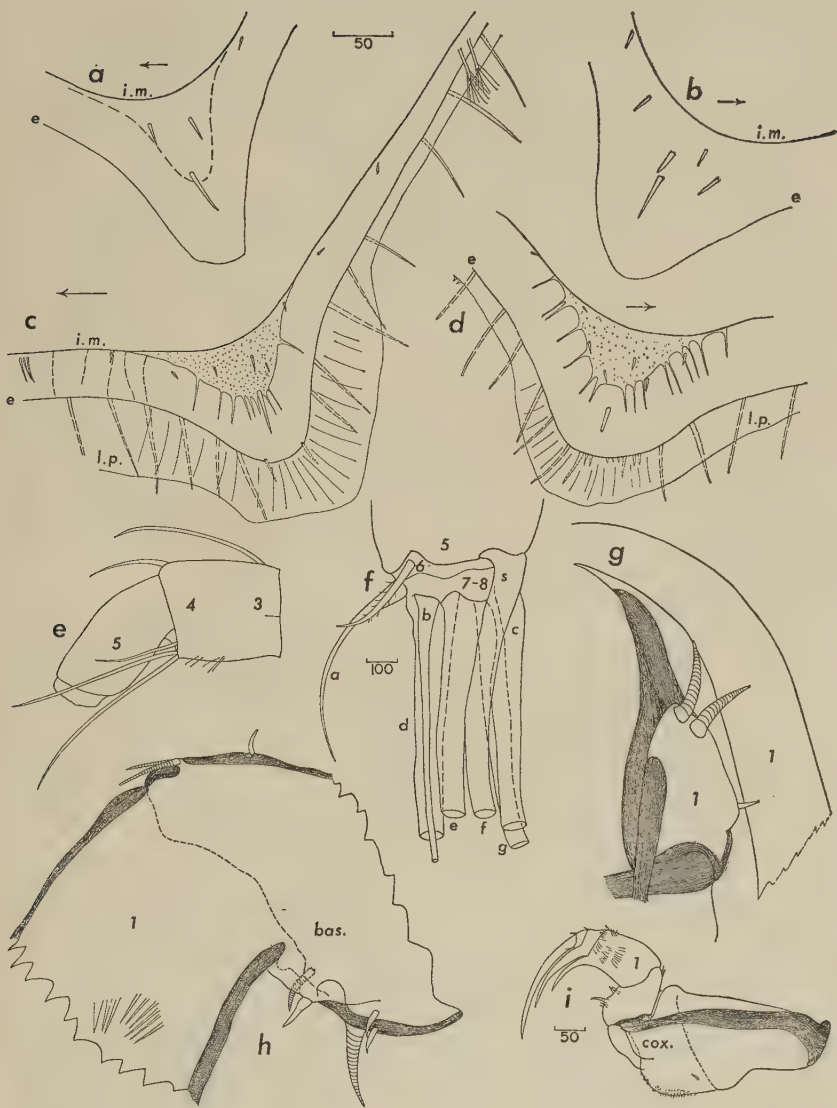

FIGURE 5.—*Sarsiella zostericola* Cushman, ♀, 1.30 mm, Texas, medial view caudal process, lamellar prolongation not shown: *a*, right valve; *b*, left valve. Female, 1.30 mm, California: *c*, caudal process and posterior of right valve; *d*, caudal process of left valve. Female, 1.26 mm, Hadley Harbor, Mass.: *e*, 1st antenna, 3rd to end joints, bristles shown only on 3rd and 4th joints; *f*, 1st antenna medial view of distal part of 5th–8th joints; *g*, 2nd antenna, endopodite and proximal part of 1st joint of exopodite; *h*, mandible, medial view, part of basale and 1st joint of exopodite; *i*, mandible complete appendage. (Same scale in microns: *a–e; f–h; i.*)

Sarsiella tricostata Jones (1958a, p. 49, fig. 1B) has 3 medium length ventral bristles on the 4th joint; only the outer 2 are annulated. On each of 3 adult females from California that I examined, the inner bristle is always shorter than the outer bristles and, although the annulations on the inner bristle are fainter than on the outer bristles, it is always annulated.

Second antenna: exopodite with 9 joints decreasing in width distally; 2nd–8th joints each with 1 long stout bristle with marginal hairs; 9th joint with 1 medium and 1 long bristle, each with marginal hairs; 7th and 8th joints each with comb of short spines along distal margins; endopodite 1-jointed with 1 short terminal spine and 2 proximal bristles dorsally (fig. 5*g*).

Cushman (1906, p. 365) described the endopodite of *S. zostericola:* "The secondary branch of the antenna of the female (pl. 28, fig. 17) is reduced to a single joint having at the tip a stout curved claw and just back from it a small pointed spine." The "stout curved claw" is actually part of the sclerotized framework connecting the endopodite to the protopodite, and the "small pointed spine" observed by Cushman is one of the proximal bristles.

Mandible (figs. 5*h*, *i*): coxale with rows of short spines along ventral margin and proximally 1 short ringed medial bristle; dorsal margin of basale with spine near midde and 2 short ringed subterminal bristles; ventral margin with 5 subequal bristles; endopodite has 1st joint with 1 short terminal dorsal spine and stout curved ventral claw, medial surface with short spines; 2nd joint with short terminal dorsal spine and stout curved ventral claw; 3rd joint with 1 short dorsal spine, 1 short ventral spine, and 1 long terminal claw.

Cushman (1906, pl. 28: fig. 18) did not illustrate the spines and bristles on the coxale of *S. zostericola*. He apparently overlooked the small spines at the bases of the 3 claws on the endopodite and medial spines on the 1st endopodite joint. On the other hand, I did not observe on 3 specimens I studied the 2 short spines proximal to the 5 dorsal bristles on the basale shown in Cushman's illustration. Cushman (1906, p. 363, pl. 27: fig. 4) described the basale of the mandible of *S. americana* as having a single bristle. He may have overlooked the smaller spines. Jones (1958a, p. 49, fig. 1D) did not describe the coxale of *S. tricostata* and did not report the medial spines on the 1st endopodite joint or the dorsal spine near the middle of the basale.

Maxilla (fig. 6*a*): protopodite with fringe of long hairs and 1 short anterior bristle; exopodite with 1 long and 2 short bristles. Basale with bristle close to exopodite; endopodite has 1st joint with terminal spinous alpha and beta bristles and 1 short subterminal spine on anterior margin; 2nd joint with 2 slender a-bristles, 1 short

c-bristle and 5 stout terminal b- and d-bristles with marginal denticulations and spines; three endites, each with about 4–5 bristles.

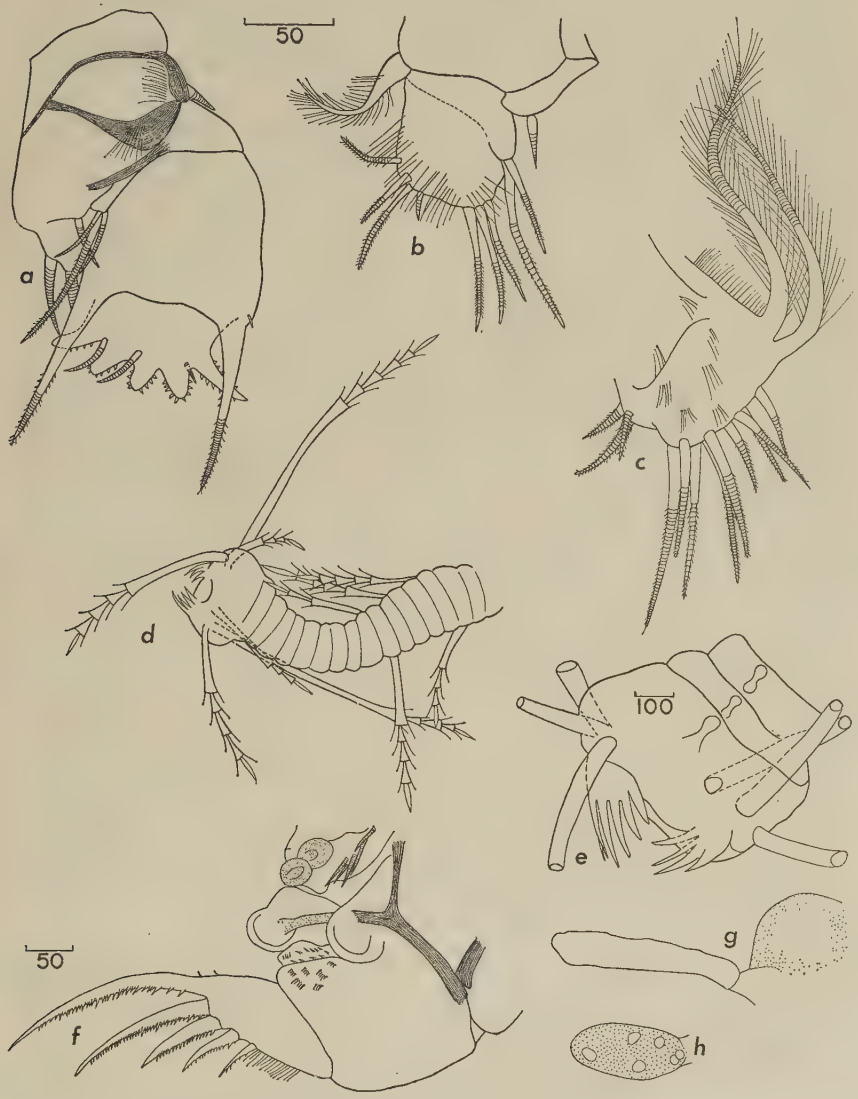

FIGURE 6.—*Sarsiella zostericola* Cushman, ♀, Hadley Harbor, Mass., 1.26 mm: *a*, maxilla, lateral view; *b*, distal part of 5th limb, lateral view; *c*, 6th limb, medial view; *d*, 7th limb; *e*, terminus of 7th limb; *f*, furca and genitalia; *g*, frontal organ and medial eye (stippled); *h*, lateral eye. (Same scale in microns: *a–d*, *g*, *h*; *e*; *f*.)

Fifth limb (fig. 6*b*): single endite with 1 short bare bristle; exopodite has 1st joint with 2 bristles; 2nd–5th joint hirsute, not separated by distinct sutures; 2nd joint with 3 bristles; 3rd–5th joints with

total of 4 bristles; surface of 2nd–5th joints with fine hairs; epipodial appendage with about 33 hirsute bristles.

Sixth limb (fig. 6*c*): single endite with 3 spinose bristles; end joint with 10 spinose bristles forming 2 rows separated by space from 2 long hirsute posterior bristles and with long hairs on posterior margin and medial surface.

Seventh limb (figs. 6*d*, *e*): terminal end with comb of about 6 teeth opposite smaller comb with 4–5 teeth; 6 bristles in distal group, 3 on each side; 4–6 bristles in proximal group; all bristles with 2–5 distal bells.

Seventh limbs from 3 Pacific and 3 Atlantic specimens were examined. All had 6 terminal bristles. The Pacific specimens and 2 of the Atlantic specimens had 4 bristles in the proximal group. The 3rd Atlantic specimen had 5 bristles on one appendage and 6 on the other. The number of bells on proximal bristles varied, with some specimens having 3–4, and others with as many as 5 or as few as 2.

Furca (fig. 6*f*): each lamella with 5 curved claws decreasing in length posteriorly; claw no. 1 joined to lamella; with lateral and medial spines in row along concave margin; 5th claw with minute spines along concave margin; margin of each lamella posterior to 5th claw with clusters of fine hairs; anterior margin of each lamella above base of 1st claw with 2 minute spines; surface above lamellae with numerous spines.

Cushman (1906, p. 363, 365, pl. 27: fig. 6) apparently overlooked the clusters of fine hairs on the margin of each lamella posterior to the 5th claw.

Genitalia (fig. 6*f*): two large vaginal openings present anterior to 5 small ringed bristles.

Frontal organ (fig. 6*g*): with short proximal joint and elongate terminal joint with rounded tip.

Eyes: medial eye large pigmented (fig. 6*g*); lateral eyes similar in size to medial eye and with 6–7 ommatidia (fig. 6*h*).

Eggs: Each gravid female has to 5–16 ovate eggs in the brood pouch, with most specimens having 10–11 eggs. All eggs in the brood pouch of a single specimen are about the same size but occasionally 1–2 are smaller than the average. Some specimens contain unextruded eggs in addition to eggs in the brood pouch. These are smaller than those in the brood pouch. Each egg appears mottled and is enclosed in an individual transparent sheath. Only 1 specimen contained larvae.

Description of adult male.—Shell (figs. 3*c*, *d*; 7*a-c*): symmetrical in dorsal view with acuminate caudal process; suboval in lateral view except for rostrum, shallow anterior sinus and truncate posterior (fig. 3*c*); surface ornamented with punctae and 3 raised ribs radiating

FIGURE 7.—*Sarsiella zostericola* Cushman, adult ♂, valves, medial view: *a*, rostrum and sinus of right; *b*, caudal process and posterior of left; *c*, caudal process of right; *d*, 1st antenna, 6th and 7th joints, medial view. 2nd antenna: *e*, endopodite; *f*, endopodite and 1st and 2nd joints of exopodite. 1st antenna: *g*, 3rd to 5th joints and part of 6th joint, filaments of sensory bristle not illustrated. Mandible: *h*, medial view, medial spines not illustrated; *i*, distal part of endopodite. (Figs. *a–d*, *g* from Point Richmond, Calif., 1.06 mm; figs. *e–f*, *h–i* from Hadley Harbor, Mass., 1.01 mm. Same scale in microns: *a–c*, *d*, *e*, *g*, *i*; *f*, *h*.)

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from hub slightly forward and below center of valve; posterior ribs terminating in knob with 2 small lateral pits; anterior and ventral ribs not reaching outer margin of valves; shell broadest at hub of radial ribs, highest near middle; valve surface with scattered short hairs; valve margins with rows of long hairs faintly annulated proximally; long hairs in row between ventral edge of valve and ventral flange; false radial pore canals numerous, true radial pore canals sparse; normal canals sparsely distributed over valve surface.

Duplicature with 1 small bare bristle below rostrum (fig. 7*a*); 3 small bare bristles and 2 hirsute bristles dorsal to caudal process (fig. 7*b*); 1 short bare bristle and cluster of 3 bare bristles anterior to caudal process (fig. 7*c*), and 2–3 medial bristles on caudal process; lamellar prolongation extending outward from selvage in area of caudal process (fig. 7*c*).

Dimensions of adult males are as follows:

Locality	*Maximum length (mm)*	*Midlength (mm)*	*Maximum height (mm)*	*Maximum width (mm)*
Massachusetts	1.01	0.97	0.60	0.55
California	1.06	1.01	0.72	–
"	1.01	0.97	0.69	–
"	0.93	0.89	0.55	–
"	0.96	0.91	0.62	–
"	1.02	0.98	0.65	–

First antenna: first joint bare; 2nd joint with 1 spinous dorsal bristle and 2 groups of spines along dorsal margin; 3rd joint with 1 dorsal bristle and without suture separating it from 4th joint (fig. 7*g*); 4th joint with 1 dorsal bristle with a few marginal hairs and 2 short ventral bristles; 5th joint triangular, inserted ventrally between 4th and 6th joints; sensory bristle of 5th joint with about 6 filaments distally and numerous filaments fringing "cup" at base; 6th joint with 1 short medial bristle with marginal spines (fig. 7*d*); 7th joint with short bare a-bristle, medium length b-bristle with a few distal filaments, and long c-bristle with distal filaments; 8th joint with long slender, bare d- and e-bristles and long stout f- and g-bristles, each with a few filaments distally; d- and e-bristles about the same length as f-bristle. The 2 ventral bristles of the 4th joint were not observed on all appendages examined. Some variation occurs in the spinosity of the bristles on the 2nd–6th joints.

Second antenna: exopodite with 9 joints decreasing in width distally; 1st joint with short, recurved medial bristle on terminal margin; 2nd–9th joints each with 1 long, stout bristle with marginal hairs; 9th joint with 1 medium and 1 long bristle, each with marginal hairs; 2nd–5th joints with comb of short spines along terminal margin. Endopodite 3-jointed (figs. 7*e*, *f*); 1st joint with 2 annulate spinous

bristles at base; 2nd joint with 3 annulate stout spinous bristles near middle; 3rd joint elongate, recurved, with 2 short, slender terminal bristles and tip with ridges.

Cushman (1906, pl. 28: fig. 11) erred in illustrating an endopodite with 4 joints. Jones (1958a, p. 52) used the 4-jointed endopodite of *S. zostericola* as one of the criteria for distinguishing that species from *S. tricostata*, which has a 3-jointed endopodite.

Mandible: coxale bare without endite; basale with 5 bristles ventrally and 3 dorsally (figs. 7*h*; 8*b*); endopodite has 1st and 2nd joints each with stout ventral claw with marginal spines and medial surface with short spines (figs. 7*i*; 8*a*); 3rd joint with long stout terminal b-claw with spines in 2 rows along proximal two-thirds and short a-, c-, and d-bristles, c-bristles considerably shorter than a- and d-bristles.

The mandible of *S. zostericola* illustrated by Cushman (1906, pl. 28: fig. 12) differs from the above in having 3 medium ventral bristles and 5 dorsal bristles on the basale. The distribution of bristles on the basale of the mandible of *S. tricostata* illustrated by Jones (1958a, fig. 1–L) is similar to that in the above description.

Maxilla (fig. 8*c*): protopodite with fringe of long hairs on margin and 1 short bristle near middle; endite of protopodite with about 4 bristles; exopodite with 3 bristles; endopodite indistinctly segmented with about 9 bristles.

Fifth limb (fig. 8*d*): single endite with 1 spinose bristle; exopodite has 1st joint with 2 spinose bristles; 2nd-5th joints not separated by distinct sutures, with total of 7 bristles; epipodial appendage with about 32 plumose bristles (only base of distal 3 bristles shown in figure).

Sixth limb (fig. 8*e*): single endite with 3 short bristles; end joint with about 10 hirsute bristles forming 2 rows separated by space from 2 long hirsute posterior bristles, and with long hairs on posterior margin and lateral and medial surfaces.

Seventh limb not observed. Males of sarsiellids usually have at least a short bare stump for a 7th limb. The absence of a 7th limb, however, was reported previously for the male of *Sarsiella georgiana* Darby, 1965 (Darby, 1965).

Furca: each lamella with 5 curved claws; claw no. 1 joined to lamella; all claws with lateral and medial spines in row along each side of concave margin; margin of left lamella posterior to 5th claw with about 10 small spines, right lamella with about 4 small spines; anterior margin of each lamella above base of 1st claw with 2–3 minute spines.

Frontal organ (fig. 8*f*): elongate with rounded tip and 2 segments.

Copulatory limb (fig. 8*h*): each limb consisting of a proximal and

distal lobe; proximal lobe with 2 short slender terminal bristles; distal lobe consisting of large smooth curved tooth with a short stout secondary tooth and 3–4 bristles at its base (2 short bristles were observed near upper part of each proximal lobe, but whether or not they originated on the lobe could not be ascertained).

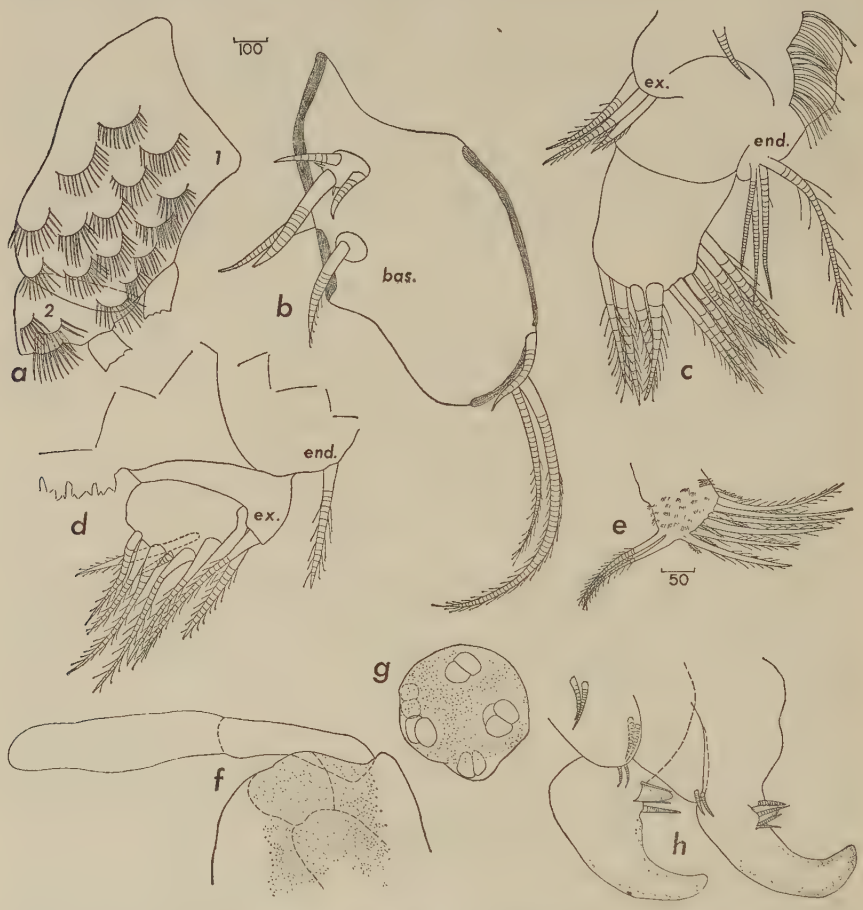

FIGURE 8.—*Sarsiella zostericola* Cushman, adult ♀: *a*, mandible, medial spines on 1st and 2nd endopodite joints; *b*, mandible, basale, medial view; *c*, maxilla; *d*, 5th limb, *e*, 6th limb; *f*, frontal organ and medial eye (stippled); *g*, lateral eye; *h*, copulatory organ. (Figs. *c-g* from Point Richmond, Calif., 1.06 mm; figs. *a-b*, *h* from Hadley Harbor, Mass., 1.01 mm. Same scale in microns: *a-d*, *f-h*; *e*.)

Cushman (1906, p. 365) described the copulatory limb as having 2 short setae at the upper end. These setae are probably equivalent to the 2 terminal bristles of the proximal lobe described above. No differences could be observed on the copulatory organs of the specimens of *S. tricostata* and *S. zostericola* I examined.

Eyes: medial eye large pigmented (fig. 8*f*); lateral eyes smaller with about 6 ommatidia (fig. 8*g*).

Description of embryo.—Shell: in lateral view oval without ornamental ridges; uncalcified; surface and margins with long bristles (fig. 9*b*); rostrum absent, posteroventral process small (fig. 9*a*)

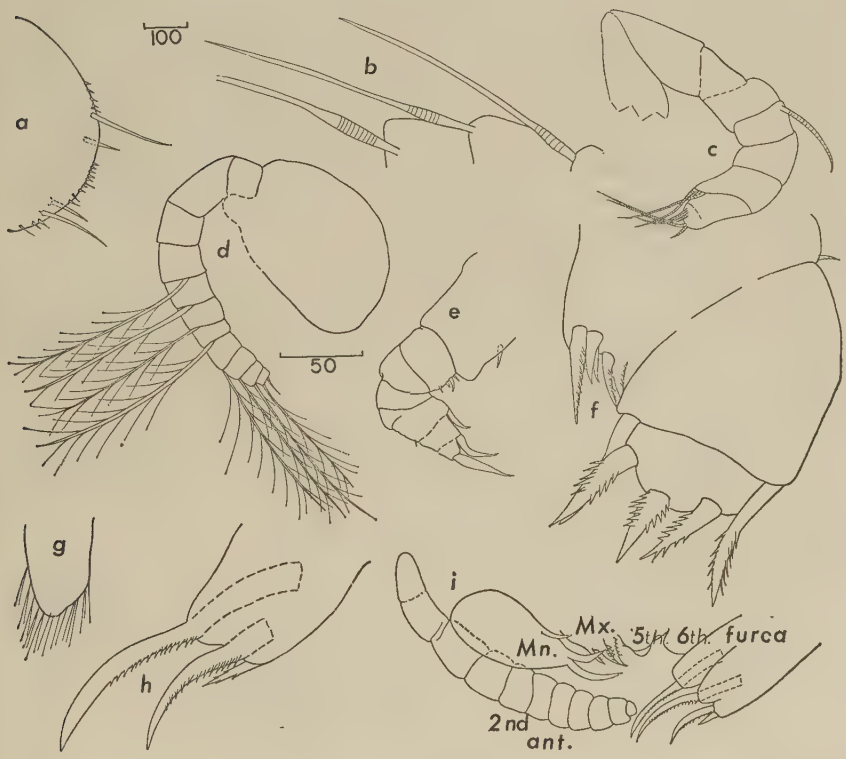

Figure 9.—*Sarsiella zostericola* Cushman, embryo, Hadley Harbor, Mass., 0.323 mm: *a*, posterior process of left valve, lateral view; *b*, bristles along anterodorsal margin of valve; *c*, 1st antenna; *d*, 2nd antenna; *e*, mandible; *f*, maxilla; *g*, 6th limb; *h*, left furcal lamella; *i*, ventral part of whole embryo showing right 2nd antenna, mandible ,maxilla, 5th and 6th limbs and lamellae of furca, all in place. Same scale in microns: *a*, *b*, *f-h*; *c-e*, *i*.

Dimensions of 4 embryos from *S. zostericola* (specimen from Hadley Harbor, Mass.) are as follows:

greatest length (mm)	*greatest height (mm)*	*greatest width (mm)*
0.315	0.276	–
0.323	0.235	–
0.314	–	0.216
0.328	0.280	–

First antenna (fig. 9*c*): divided by sutures into about 8 joints; long annulate bristle dorsally near middle, 6–7 bristles terminally.

Second antenna (figs. 9*d*, *i*): exopodite with 11 joints; joints 1–3 without bristles; joints 4–10 each with 1 hirsute bristle; joint 11 with 1 short and 1 long bristle; endopodite consists of small mode without bristles.

It is interesting to note that the 2nd antennae on embryos of *Gigantocypris agassizi* Müller, 1895, examined by Poulsen (1965, p. 37) also had more joints than on the adult. Hairs on bristles of the exopodite on the embryo are longer than on the adult, suggesting that the larvae after hatching are capable of swimming. Joints 1–3 of the exopodite on embryo are equivalent to the 1st joint on the adult.

Mandible (figs. 9*e*, *i*): coxale with short bristle proximally; basale with 4 or 5 subequal bristles ventrally; endopodite 3-jointed; each joint with weakly sclerotized claw.

Maxilla (figs. 9*f*, *i*): protopodite with short anterior bristle; endopodite has 1st joint with spinous alpha and beta bristles; 2nd joint with 3 denticulate b- and d-bristles; 3(?) endites, each with bristles, some bristles with marginal spines.

Fifth limb (fig. 9*i*) and 6th limb (figs. 9*g*, *i*): leaflike hirsute.

Furca (figs. 9*h*, *i*): each lamella with 3 claws; all claws with marginal spines; anterior margin of right lamella above claw no. 1 with clusters of hairs (not shown in figure).

Frontal organ: minute, transparent, 1-jointed.

Eyes: not observed.

Description of female instar III (fig. 10).—Shell: lateral view oval, without rostrum; posterior truncate, with caudal process. Measurements of selected specimens are as follows:

locality	*midlength (mm)*	*midheight (mm)*
California	0.54	0.48
"	0.56	0.46
"	0.60	0.47
"	0.55	0.42

First antenna (fig. 10*a*): fourth joint without ventral bristles, otherwise similar to adult female.

Second antenna (fig. 10*b*): endopodite 1-jointed, with small terminal bristle and 1 short dorsal bristle; exopodite 9-jointed, similar to adult female; joints 2–6 with terminal comb of short spines; bristles of 2nd, 3rd, 9th joints with short spines proximally along outer margins.

Mandible, maxilla: similar to adult female.

Fifth limb: similar to adult female except for having only 2 bristles on 2nd joint of exopodite.

Sixth limb (fig. 10*c*): leaflike with hirsute margin and 1 terminal bristle.

Seventh limb (fig. 10*d*): short stump without terminal comb or bristles.

Furca: similar to adult female except for fewer teeth on 4th and 5th claws.

Frontal organ: 1-jointed with rounded tip.

Eyes: medial eye large, pigmented; lateral eyes about same size as medial eye, with about 4 divided ommatidia.

Genitalia: undeveloped.

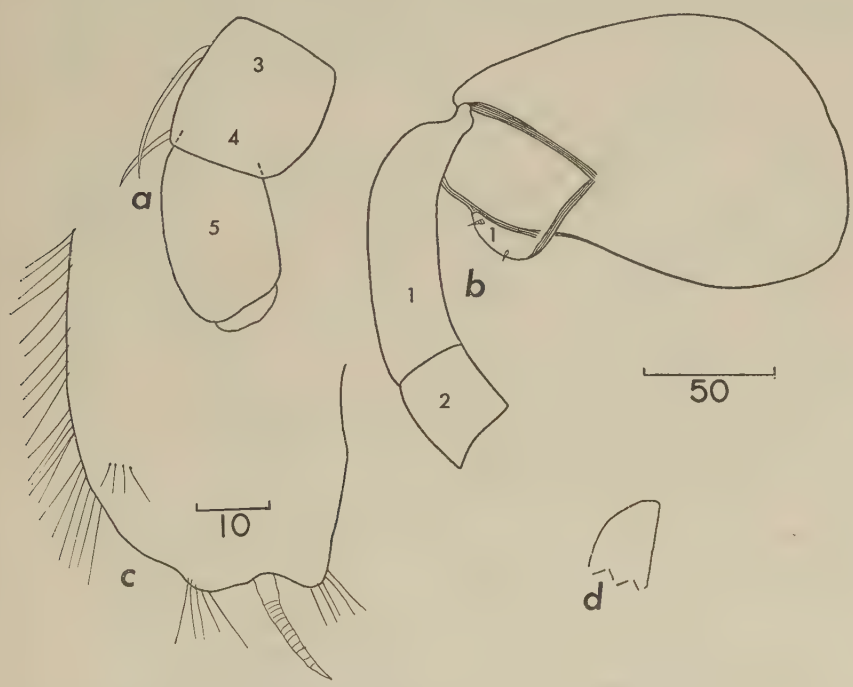

FIGURE 10.—*Sarsiella zostericola* Cushman, stage III ♀ from California: *a*, 1st antenna, 3rd to end joints, bristles shown only on 3rd and 4th joints; *b*, 2nd antenna, protopodite, endopodite, 1st and 2nd joints of exopodite; *c*, 6th limb; *d*, 7th limb. (Same scale, in microns: *a*, *b*, *d*; *c*.)

DESCRIPTION OF FEMALE INSTAR IV (fig. 11).—Shell: lateral view, oval, similar to female instar III, but more rounded. Dimensions of selected specimens are as follows:

locality	*midlength (mm)*	*midheight (mm)*
California	0.71	0.59
"	0.73	0.62
"	0.72	0.60
"	0.67	0.59
"	0.64	0.55

First antenna (fig. 11*a*): fourth joint with 1 ventral bristle; otherwise similar to adult female.

Second antenna: endopodite 1-jointed with short terminal spine and 1–2 short annulate dorsal bristles (fig. 11*b*); exopodite similar to adult female; bristles on 2nd and 3rd joints and 9th joint with short spines proximally along outer margin.

Mandible, maxilla, 5th limb, furca: similar to adult female.

Sixth limb: endite with 2 subequal bristles; end joint with 8 bristles, otherwise similar to adult female.

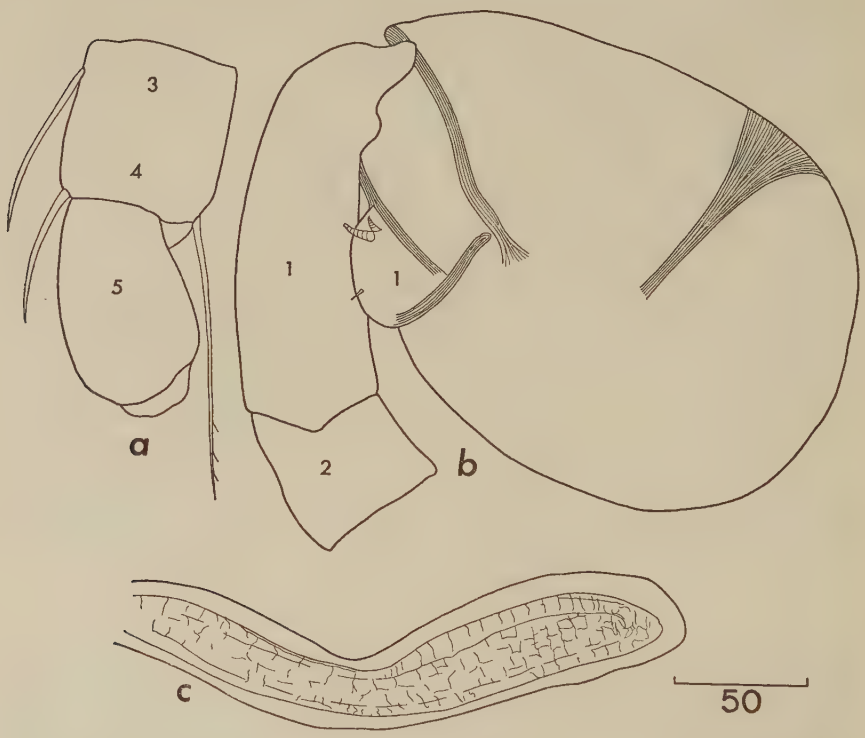

FIGURE 11.—*Sarsiella zostericola* Cushman, stage IV ♀ from California: *a*, 1st antenna, 3rd to end joints, bristles shown only on 3rd and 4th joints; *b*, 2nd antenna, protopodite, endopodite, 1st and 2nd joints of exopodite; *c*, 7th limb. (Scale in microns.)

Seventh limb (fig. 11*c*): elongate without bristles or terminal comb.

Eyes: medial eye large, pigmented; lateral eyes about same size as medial eye.

Frontal organ: 1-jointed with rounded tip.

Genitalia: undeveloped.

DESCRIPTION OF FEMALE INSTAR V (fig. 12; pl. 2).—Shell: oval in

lateral view; posterior more truncate than adult female. Dimensions of selected specimens are as follows:

locality	*midlength (mm)*	*midheight (mm)*	*remarks*
California	0.89	0.79	eggs in ovaries
"	0.95	0.80	–
"	0.96	0.79	–
"	0.89	0.76	–

First antenna (fig. 12*a*; pl. 2*a*): 4th joint with 1 long and 1 medium ventral bristle, otherwise similar to adult female.

Second antenna, mandible, maxilla, 5th limb, 6th limb, furca (pl. 2*b*): similar to adult female.

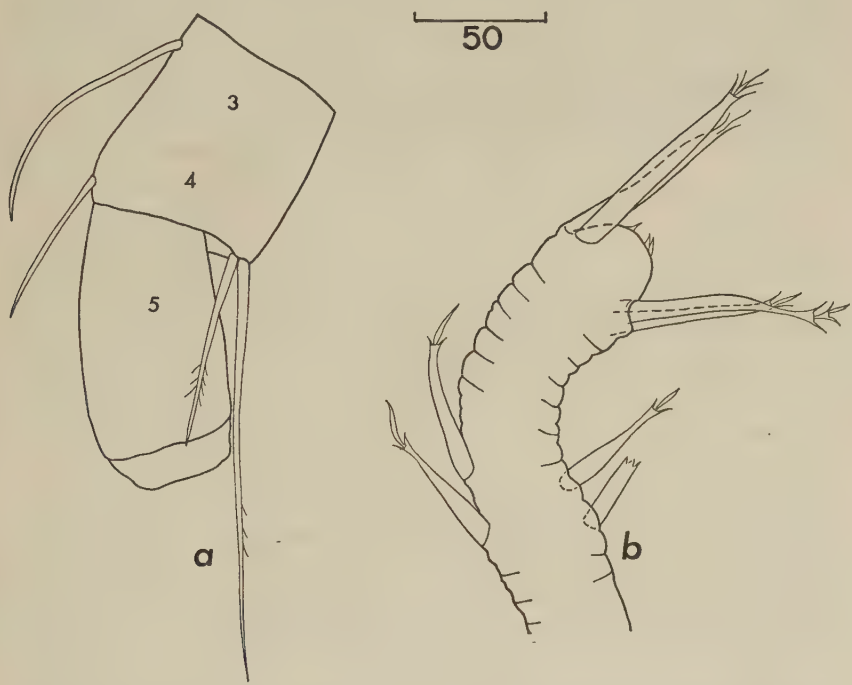

FIGURE 12.—*Sarsiella zostericola* Cushman, stage V ♀ from California: *a*, 1st antenna, 3rd to end joints, bristles shown only on 3rd and 4th joints; *b*, 7th limb (one of lateral bristles broken). (Scale in microns.)

Seventh limb (fig. 12*b*): terminal end with 4 small teeth near tip; 4 bristles in distal group, 2 on each side; 4 bristles in proximal group, 2 on each side; all bristles with 1–2 bells distally.

Frontal organ (pl. 2*a*): 2-jointed with rounded tip.

Eyes (pl. 2*a*): medial eye large, pigmented; lateral eyes about same size as medial eye, with 4 or 5 divided ommatidia.

Genitalia (pl. 2*b*, *c*): undeveloped.

Eggs (pl. 2*d*): about 5 eggs in ovary of 1 specimen. Absence of developed genitalia in instar V indicates that eggs, when present at this stage, are not fertilized.

Description of male instar III (fig. 13).—Shell: more elongate and slightly smaller than female instar III. Dimensions of a selected specimen are as follows:

locality	*midlength (mm)*	*midheight (mm)*
California	0.53	0.40

First antenna (fig. 13*a*), 5th, 6th, 7th limbs (fig. 13*c*), furca, eyes, frontal organ: similar to female instar III.

Second antenna: endopodite 2-jointed (fig. 13*b*); 1st joint with 1 dorsal bristle; 2nd joint with 1 small terminal bristle; exopodite 9-jointed, similar to mature female; bristles on 2nd to 4th joints and 9th joint with short marginal spines proximally.

Mandible, maxilla: similar to adult female.

Copulatory limb: undeveloped.

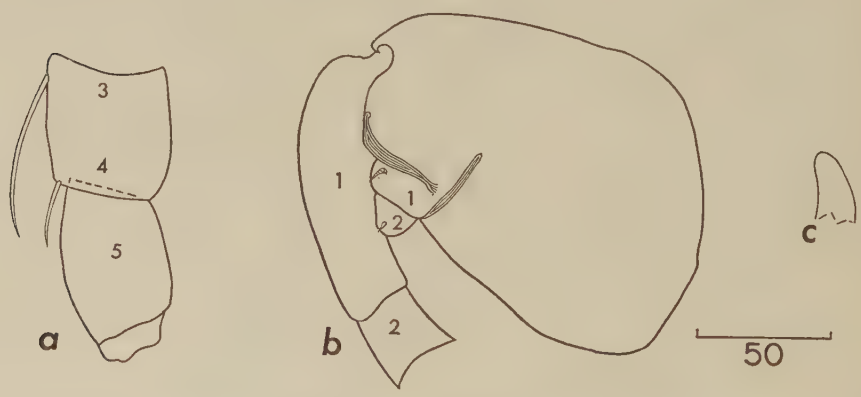

Figure 13.—*Sarsiella zostericola* Cushman, stage III ♂ from California: *a*, 1st antenna, 3rd to end joints, bristles shown only on 3rd and 4th joints; *b*, 2nd antenna, protopodite, endopodite, 1st and 2nd joints of exopodite; *c*, 7th limb. (Scale in microns.)

Description of male instar IV (fig. 14).—Shell: slightly more elongate and smaller than female instar IV. Dimensions of a selected specimen are as follows:

locality	*midlength (mm)*	*midheight (mm)*
California	0.59	0.50

First antenna (fig. 14*a*), 6th limb, frontal organ, eyes: similar to female instar IV.

Second antenna: endopodite 2-jointed (fig. 14*b*); 1st joint with 1–2 short annulate bristles; 2nd joint with 2 subequal bristles near middle and 1 short stubby bristle terminally; exopodite similar to adult

female; bristles on 3rd and 4th joints with short spines proximally along outer margin.

Mandible, maxilla, 5th limb: similar to adult female.

Seventh limb (fig. 14*c*): short stump.

Copulatory limb: consists of 2–3 lobes, hook not developed.

Description of male instar v (fig. 15; pl. 2*e–o*).—Shell: More elongate and slightly smaller than female instar V. Dimensions of selected specimens are as follows:

locality	*midlength (mm)*	*midheight (mm)*
California	0.81	0.63
"	0.84	0.68

First antenna (fig. 15*a*; pl. 2*e*, *f*), eyes, and frontal organ (pl. 2*o*): similar to female instar V.

Second antenna (fig. 15*b*; pl. 2*e*, *g*, *h*): endopodite 3-jointed (fig. 15*b*): 1st, 2nd, and 3rd joints each with 2 short bristles; bristles on 3rd joint terminal; exopodite similar to adult female.

Mandible (pl. 2*e*, *i*), maxilla (pl. 2*j*, *k*), 5th limb (pl. 2*l*), 6th limb (pl. 2*m*), furca (pl. 2*n*): similar to adult female.

Seventh limb (fig. 15*d*): short stump.

Copulatory limb (fig. 15*c*): consisting of hooklike "clasping organ" and large transparent lobe having medially a smaller lobe with small bristle.

Summary of development.—Shell (fig. 2): Bristles on the outer side of the shell seem already fully developed in the embryo. Also present in the embryo are 2 hirsute bristles on the posterodorsal part of the inner lamella. The inner side of the caudal process of the embryo was not observed, but the distribution of bristles on the outer side of the caudal process is similar to that of the adult. All instars have truncate posteriors somewhat similar to the adult male. In lateral view, the posterior is more rounded in the adult female than in the instar, and the caudal process is on the ventral margin of the shell. In dorsal view, the shell is broadest in instar stages near the middle of the shell, where the radial ridges intersect. In the adult female the posterior of the shell is relatively broader than in instars, and in many the posterior is the broadest part of the shell.

Shells of male instars are similar to equivalent stages of the female but are slightly smaller and more elongate. The adult male is about the same height as the shell of instar V but is longer. It has a prominant rostrum, and the posterior is truncate as in the shells of juveniles. The shell of the adult male is much smaller than the adult female.

First antenna: In the embryo the 1st antenna is divided into about 8 joints by sutures. One long annulate bristle is located dorsally near the middle and about 7 bristles are terminal. In instar III, the 1st

antenna has essentially the same form as the adult female but has no ventral bristles on the 4th joint. The number of ventral bristles on the 4th joint increases with each instar: 1 in instar IV, 2 in instar V, and 3 in the adult. The outer bristle is formed first and each succeeding bristle is added on the inside.

In the adult male the 6th joint is elongate; the 5th joint consists of a small triangle wedged ventrally between the 4th and 6th joints, and the sensory bristle has at its base a small cuplike process bearing numerous thin filaments.

Second antenna: In the embryo the exopodite of the 2nd antenna is divided into 11 joints: each joint from 4 to 10 bears a long hirsute bristle; joint 11 bears 1 long hirsute bristle and 1 short bristle. Marginal hairs on the bristles of the exopodite are relatively longer on the embryo than on older stages. Except for small variations in distribuition of marginal spines on bristles, the exopodite of the 2nd antenna is essentially the same from instar III to the adult. The endopodite

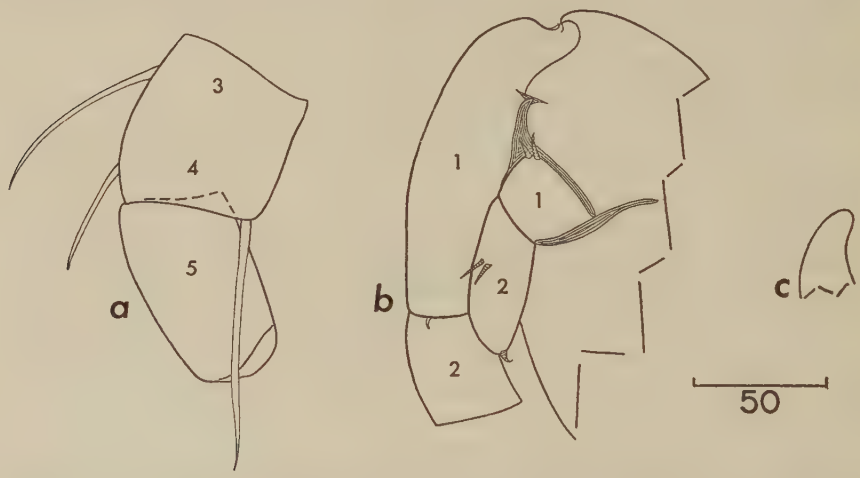

FIGURE 14.—*Sarsiella zostericola* Cushman, stage IV ♂ from California: *a*, 1st antenna, 3rd to end joints, bristles shown only on 3rd and 4th joints; *b*, 2nd antenna, endopodite, 1st and 2nd joints of exopodite; *c*, 7th limb. (Scale in microns.)

of the embryo consists of a node without bristles. The endopodite on the female is 1-jointed and has 1 terminal bristle on all stages from instar III through the adult, but the number of dorsal bristles varies: 1 on instar III, 1–2 on instar IV, 2 on instar V and the adult.

In instar III of the male the endopodite is 2-jointed with 1 dorsal bristle on the 1st joint and a small terminal bristle on the 2nd; in instar IV the 1st joint has 1–2 dorsal bristles, and the 2nd joint has 2 subequal bristles near the middle and 1 short stubby bristle terminally; instar V is 3-jointed: the 1st joint has 2 bristles near the base;

the 2nd joint has 2 short bristles near the middle; the 3rd joint has 2 short terminal bristles. A 3rd bristle is present on the 2nd joint of the adult.

Mandible: In the embryo the claws of the endopodite are only weakly sclerotized. The mandible of instars III–IV and the adult female are similar. The adult male differs in having longer dorsal bristles on the basale and in having the claw of the 1st endopodite joint situated more proximally on the ventral margin.

Maxilla: In the embryo the 2nd joint of the endopodite has only 3 b- and d-bristles. The maxilla of instars III–V and the adult female are similar. The maxilla of the adult male differs from the female in being smaller, having 1 instead of 3 endites, and in having bristles of the end joints distributed differently.

Fifth limb: In the embryo the 5th limb is poorly developed and minute. In instar III it is similar to the adult female except for having 2 instead of 3 bristles on the 2nd exopodite joint. Instars IV and V are similar to the adult female. The 5th limb of the adult male differs from the female in being considerably smaller and also in the distribution of marginal hairs on bristles.

Sixth limb: In the embryo the 6th limb is minute and foliaceous with marginal hairs. In instar III the 6th limb has 1 terminal bristle. In instar IV the 6th limb is similar to the adult female with the exceptions of having 2 instead of 3 bristles on the endite and 8 instead of 10 bristles on the end joint. Instar V is similar to the adult female. The 6th limb of the adult male is somewhat smaller than on the female.

Seventh limb: In the embryo the 7th limb was not observed and is probably absent. In the female in instar III the 7th limb is a short stump, in instar IV the 7th limb is elongate but bare; in instar V the 7th limb has 4 small teeth near the tip, 4 distal bristles and 4 proximal bristles; in the adult the 7th limb has a terminal comb of about 6 teeth opposite a smaller comb with 4–5 teeth, 6 distal bristles, and 4–6 proximal bristles. In the male the 7th limb consists of a short stump on instars and is absent or negligible in adult.

Furca: In the embryo the furca has only 3 claws. In instars III–V the furca is essentially the same as in the adult except for variations in the distribution of marginal teeth on proximal claws.

Copulatory organs: In the female instars III–V the genitalia are poorly developed; in the adult the genitalia contains 2 large vaginal openings. In the male genitalia are undeveloped on instars III and IV; on instar V the copulatory limb is bilobate and has a hooklike "clasping organ"; in the adult the hooklike organ is strongly developed and complicated, and each lobe bears 2–4 bristles.

Frontal organ: In the embryo and instars III and IV the frontal organ is elongate and 1-jointed with a rounded tip. In instar V and

in the adult the frontal organ is 2-jointed but the presence or absence of a suture dividing the organ into 2 joints is difficult to establish with certainty because of folds and creases that develop in the appendage.

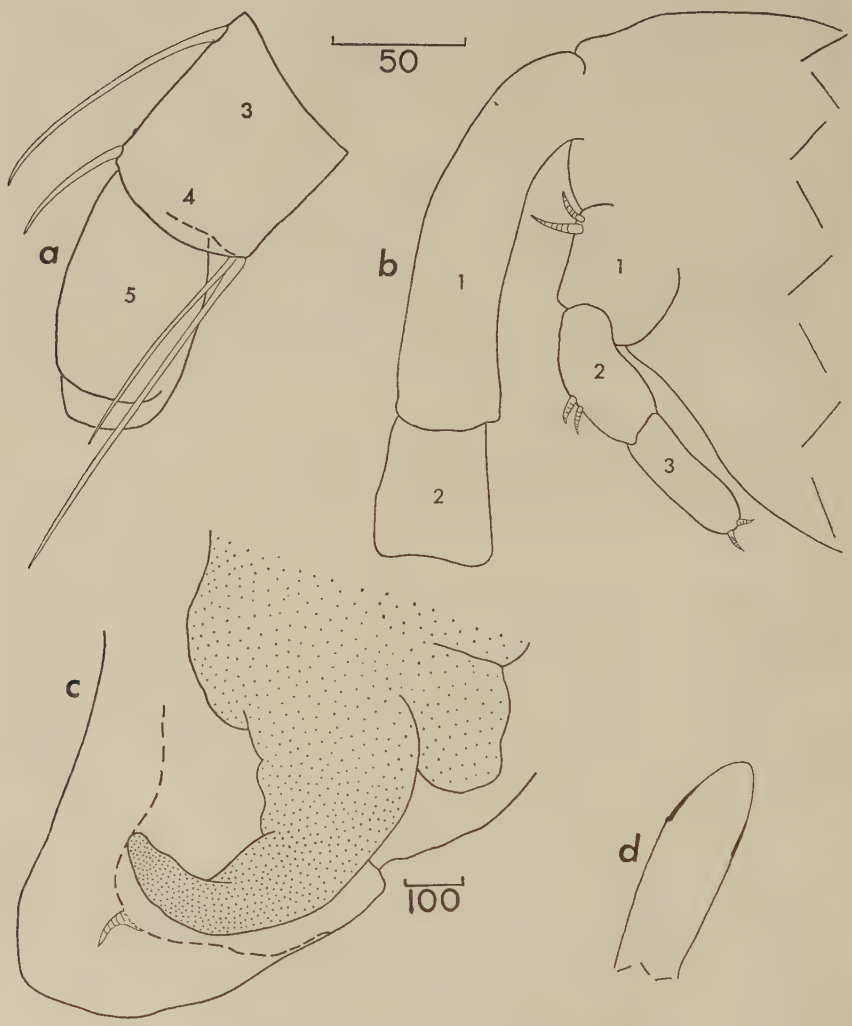

FIGURE 15.—*Sarsiella zostericola* Cushman, stage V ♂ from California: *a*, 1st antenna, 3rd to end joints, bristles shown only on 3rd and 4th joints; *b*, 2nd antenna, endopodite, 1st and 2nd joints of exopodite; *c*, copulatory organ; *d*, 7th limb. (Same scale in microns: *a*, *b*, *d*; *c*.)

Eyes: Lateral eyes were not observed in embryo but are present along with a medial eye in instars III–V and in adults. The lateral eye of the adult male may be smaller than on the female.

Reproduction.—Eggs were observed in the ovary of 1 pre-adult (stage V) female. Since the genitalia of the stage V females were not completely developed, however, we can conclude that eggs are probably not fertilized at this stage. Apparently eggs remain in the ovary of the pre-adult until the adult stage when the posterior of the adult shell broadens to accommodate the eggs.

Most gravid adult females in the collection have 10–11 eggs in the brood chamber but the observed range is 5–16. Some specimens have eggs both in the ovaries and brood chamber. Embryos with well-developed appendages were observed in only one specimen. Jones (1961, figs. 20d–f) reported that at least 55 percent of adult females in collections made throughout the year off Point Richmond, Calif., contain either eggs or embryos.

Prior to molting it is often possible to observe the new appendages and valves inside the old. About 20 adult females with eggs in the brood chamber were examined but no indication of post-adult molting was observed.

Ecology.—Water depth: Specimens of *S. zostericola* were collected in the Hadley Harbor area at depths of not more than 6 m. Blake (1933, p. 230) collected *S. zostericola* from along the coast of Maine at depths of 1–22 m, but specimens were sparse at 22 m. Specimens of *S. zostericola* from the Texas coast were collected in 1–2 m of water (Kornicker and Wise, 1962). In the Point Richmond area, Calif., *S. zostericola* was collected at depths of 2–11 m (Jones, 1954.) The tabulation below from data in Jones (1954) shows that ostracod abundance decreases markedly at depths below about 6 m (20 ft).

The distribution of *S. zostericola* at various depths in the vicinity of Point Richmond, Calif., is as follows (Jones, 1954):

water depth (feet)	*number of samples with ostracods*	*percent of samples with ostracods*	*number of ostracods in samples*	
			average per sample	*range per sample*
1–10	27	81.5	8	1–36
11–20	15	73.3	11	1–54
21–40	12	50.0	4	1–9

Temperature and salinity: In the Point Richmond area, Calif., *S. zostericola* was collected at temperatures from 17.2°C to 18.8°C and salinities from 22 to 30‰ (see tabulation on p. 32). Along the coast of Texas specimens were collected at temperatures from 16.2°C to 25°C and salinities from 20 to 36‰ (Kornicker and Wise, 1962).

Substrate: Specimens of *S. zostericola* were collected in Hadley Harbor in sediment with a median diameter of 60 microns and sorting index (SO) of 2.5 (Nagle, in litt., 1965). In the Point Richmond area, Calif., *S. zostericola* was collected from grey to black muds composed of more than 64 percent of particles in the fine sand to clay

range (see tabulation below). In the Texas area specimens were collected from mud, sand, and shell (Kornicker and Wise, 1962). In the "Gulf of Canso," Cushman (1906, p. 366) found specimens of both sexes clinging to eel grass and hydroids (*Pennaria tiarella*).

Food: A complete harpacticoid copepod (identified by T. E. Bowman) was in the stomach of a juvenile female from the Point Richmond area, Calif. The copepod contained some internal organs indicating that it was swallowed alive. The relatively large size of the copepod suggests that *S. zostericola* is capable of stretching its esophagus to several times its relaxed diameter while ingesting prey.

Behavior: Kornicker and Wise (1960) showed experimentally that *S. zostericola* burrows more rapidly in silty sand than in oolitic sand. Jones (1961, p. 290, table 2) reported that off Point Richmond, Calif., 92 percent of specimens of *S. zostericola* were collected in cores of sediment at depths within the cores of 0-20 mm, 8 percent at 20–40 mm, and none below 40 mm. Jones (1961, p. 262) stated that specimens in the core deeper than 20 mm were probably pushed to that depth by the coring tube.

The California Department of Public Health (1954) gives the environmental data from the vicinity of Point Richmond, Calif., as follows:

	total range	*range at stations containing ostracods* [a]	*total number of samples*	*date of collecting*
water [b]				
dissolved oxygen ppm	6.6–9.0	6.6–8.6	50 [c]	Oct. 5, 1953
temperature °C	17.2–19.8	17.2–18.8	50 [c]	" " "
chlorides ppm	12,000–17,800	12,000–16,900	50 [c]	" " "
sediment				
sulphide ppm	17–647	79–647	25	Sept. 14, 15, 1953
volatile solids %				
wet basis	0.5–4.8	0.5–4.8	24	" " " "
dry basis	0.7–16.0	0.7–11.4	24	" " " "
particles smaller than 0.104 mm %	64.7–98.5	64.7–97.0	65	" " " "
water depth (feet)	5–37+	6–37+	56	" " " "

[a] Ostracods were collected on Sept. 14, 15, 1953, using an Eckman grab sampler. Ostracods were collected from sediment samples, not water samples.

[b] Water samples were taken 3–4 feet below the surface with a Kemmerer water sampler.

[c] Number represents 25 samples at low tide and 25 at high tide from same stations.

Sarsiella capsula Norman, 1869

FIGURE 16; PLATE 3

Sarsiella capsula Norman, 1869, p. 293.—Brady and Norman, 1896, p. 677, pl. LX (figs. 1–4, 18).

Sarsiella levis Müller, 1894, p. 216, pl. 4 (figs. 11, 19, 20, 23, 24, 26, 32, 36, 45–47), pl. 8 (figs. 2, 3).

Nematohamma obliqua Brady and Norman, 1896, pp. 680–682, pl. LII (figs. 1, 2), pl. LIII (figs. 12–15).

Not *Sarsiella capsula*, Sars, 1888, p. 229, pl. III (figs. 5–7), pl. X [probably *Sarsiella*, new species].—Müller, 1894, p. 214, pl. 4 (figs. 4–6, 8–10, 22, 25, 27–29, 31, 33–35, 37, 48), pl. 8 (figs. 6, 7) [probably *Sarsiella*, new species].—Brady, 1911, p. 395 [listed, probably *Sarsiella*, new species].—Rome, 1942, p. 8 [listed, probably same species as Müller, 1894]; 1964, p. 4 [listed].

Holotype: *S. capsula* Norman, 1869, unique, female.

Norman (1869, p. 293) described *S. capsula* from a single specimen collected in the vicinity of the Shetland Islands. His description included only the external features of the carapace and was not illustrated. Brady and Norman (1869, p. 677, pl. LX: figs. 1–4, 18) emended the description and illustrated the carapace and the maxilla. In addition to the Shetland Island specimen, they had available specimens collected by Norman from Valentia, Ireland, and the Gulf of Naples, Italy. They state (1896, p. 678) that the male is unknown.

A Shetland Island specimen and 3 specimens from Valentia are together on a dry slide (1911. 11. 8, M 3985) in the Norman Collection at the British Museum (Natural History). It is not possible to establish which of the specimens is from the Shetland Islands. Fortunately, Brady and Norman (1896) correctly identified the Valentia specimens so that all 4 specimens on the slide may be used to characterize the species. The slide contains 2 adult females and 2 juveniles (pl. 3*a–d*).

Specific locality data on the back of the slide (10 miles off Balta, Shetland, 73 fath.) does not agree with that given in Norman's 1869 publication (St. Magnus Bay, Shetland, 30–60 fath.); therefore, it is possible that the specimen on the slide is not the holotype. I am inclined to believe, however, that wrong locality data was published. Otherwise, I think that another specimen from the Shetland Islands would have been in the Norman Collection at the British Museum. If the holotype is lost, however, the specimen on the slide is at least a specimen from the same general locality and identified by the same author and therefore the best specimen available on which to base the species.

Comparison of the carapaces of the specimens of *S. capsula* from the Shetland Islands and Valentia with specimens identified as *S. capsula* by Müller (1894), Brady (1911), and Rome (1942) and with the description of *S. capsula* by Sars (1888) revealed that they are not conspecific. *Sarsiella capsula* Norman has in the posterodorsal region a flat-topped, crestlike prominence, whereas the other species have 2 conical projections and probably belong in 1 or more new species.

On the other hand, when the carapaces of specimens identified by Müller as *Sarsiella levis* Müller, 1894, were compared with *S.*

capsula Norman, they were found to be identical and, therefore, *S. levis* has been placed in synonymy with *S. capsula*.

Misidentifications of Sars (1888) and Müller (1894) are understandable considering the unillustrated description of Norman (1869), which could include many extant sarsiellids. Actually Müller (1894) prefaced his *S. capsula* identification with a "?" but this was omitted in his synoptic work in 1912. Both males and females of *S. capsula* and *S. levis* were described and illustrated by Müller (1894).

Brady and Norman (1896) established the genus *Nematohamma* to receive their new species *N. obliqua*, which was based on males collected off Valentia and Birterbuy Bay, Ireland. *Nematohamma obliqua* was placed in synonomy with *S. levis* Müller by Müller (1912). As previously stated, *S. levis* is a synonym of *S. capsula* Norman; therefore, *N. obliqua* is also a synonym of *S. capsula* Norman. I have compared carapaces of of *S. capsula* Norman from the Shetland Islands and Valentia with the carapace of a specimen of *N. obliqua* from Valentia (Norman Collection, British Museum) and find that they are indeed conspecific. A carapace of *N. obliqua* from off Valentia (from slide 1911.11.8, M3989, British Museum) is illustrated in plate 3*e*.

MATERIAL.—Information concerning specimens examined is as follows:

contents of label (location of material)	*remarks*
1. 1911.11.8, M3986; *Sarsiella capsula* Norman, Madeira, off Praia Bay, 50 fathoms, A.M.N. 1897 [British Museum]	A dry slide containing a left and right valve. Absence of a posterodorsal prominence indicates it is not conspecific with *S. capsula* Norman but is probably a new species. Occurrence of the species off Madeira was reported in Brady (1911).
2. 1911.11.8, M3985; *Sarsiella capsula* Norman, Types, Shetland 1863 & Valentia 1870 [British Museum]	Specimens in this dry slide are illustrated in figures 16*a-d*. The back of the slide contains these notations: "a, 10 miles off Balta, Shetland 73 fathoms; b. off Valentia, 112 fathoms." These data do not agree with locality and depth information for Shetland given in Norman (1869, p. 293). The date (1863) does not agree with the date of 1869 given by Brady and Norman (1896).
3. 1911.11.8, 37013; *Sarsiella capsula* Norman, Birterbuy Bay, Ireland, 1874 [British Museum]	A vial containing a whole specimen preserved in preservative.

contents of label (location of material)	*remarks*
4. 1900–3–6–456; *Sarsiella capsula*, off Capri, Bay of Naples, April, 1887 [British Museum]	A dry slide containing a dry whole mount, a female.
5. 1900–3–6–457; *Sarsiella capsula*, off Valentia, Ireland, 1870 [British Museum]	A slide containing mounted appendages of an adult female.
6. 1900–3–6–458; *Sarsiella capsula*, off Valentia, Ireland, 1870 [British Museum]	A slide containing mounted appendages of an adult female. Illustrations of appendages in this paper are from appendages on this slide.
7. 1911.11.8, M3987; *Nematohamma obliqua* Bra[dy] and Nor[man], Type, Valentia Ireland, 1870 [British Museum]	A slide containing appendages of a dissected specimen. Specimen was reported in Brady and Norman (1896).
8. 1911.11.8, M3988; *Nematohamma obliqua* Bra[dy] and Nor[man], Type, Birterbuy Bay, Ireland, 1874 [British Museum]	A slide containing appendages of a dissected specimen. Specimen was reported in Brady and Norman (1896).
9. 1911.11.8, M3989: *Nematohamma obliqua* Bra[dy] and Nor[man], Type, off Valentia, 112 fath. 1870 [British Museum]	A dry slide containing a whole specimen in good condition. Specimen was reported in Brady and Norman (1896). The bottom of the slide contains the pencilled notation: "Philomedes Folinii, off Valentia, 112 fath. 1870." This specimen is illustrated in figure 16*e*.
10. Acc. Cat. No. 25019; *Sarsiella capsula* Norman [Zoological Institute of Greifswald]	Vial containing about 15 specimens including 1 adult male. These specimens were collected by G. W. Müller from the Gulf of Naples and reported in Müller (1894).
11. Acc. Cat. No. 25020; *Sarsiella levis* Müller [Zoological Institute of Greifswald]	Vial containing about 6 specimens including 1 adult male. These specimens were collected by G. W. Müller in the Gulf of Naples and reported in Müller (1894).
12. *Sarsiella capsula* Norman, 20–30 M, 19/21/39, Station 07722, Rocquerbrane ♂ [Zoological Station of Naples]	A slide containing a whole specimen mounted in balsam. It is a juvenile of a species similar to *S. capsula* of Müller, not Norman. Collected by Dom. R. Rome.

Description of adult female.—Shell (pl. 3*a*, *b*): Oval in lateral view with posteroventral caudal process; posterodorsal part of shell inflated, median part depressed. Ornamentation: prominent ridge within and parallel to dorsal and ventral margins of shell becoming faint or disappearing anteriorly and posteriorly but forming crest along dorsal margin of posterodorsal inflation; 7 radial ridges within anterior and ventral submarginal regions; 3 anterior, 3 ventral, and 1 extending onto caudal process. Surface punctate.

Typical of sarsiellids, the caudal process of *S. capsula* is more anteriorly located on adults than on juveniles (pl. 3*c*, *d*). The shell of *S. capsula* illustrated by Brady and Norman (1896, pl. LX: figs. 1–4) has the caudal process posterior, suggesting that it is a juvenile. The lateral outline of the carapace is similar to that of the specimen illustrated in plate 3*c* of this paper.

Both adult females and juveniles have 3 prominent radial ridges anteriorly. Three ventral radial ridges on juveniles may be present on adults also; however, it is not possible to be certain of the ridges on the adults because the ventral margins of both adult shells on the type slide are considerably distorted. Juveniles, adult females, and males (*N. obliqua*) (pl. 3*e*) have the flat-topped, crestlike prominence on the posterodorsal part of the shell.

Measurements: Because adult specimens on slide no. 1911.118, M3985 (British Museum) are somewhat distorted, the dimensions given below must be considered as approximate (the letters used to designate specimens refer to specimens illustrated in plate 3):

specimen	*length (mm)*	*height (mm)*	*developmental stage*
a	1.2	09.	adult ♀
b	1.2	0.9	adult ♀
c	0.7	0.6	juvenile
d	0.5	0.4	juvenile
e	1.2	0.7	adult ♂

Norman (1869, p. 293) recorded the length of the carapace of *S. capsula* as about 1/15 inch [about 1.7 mm]. Brady and Norman (1896, p. 678) recorded the length of *S. capsula* as 1.2 mm and height as 1 mm. The dimensions given by the latter authors are close to my measurements of female adults.

First antenna (fig. 16*a*): 1st joint bare; 2nd joint with 1 dorsal bristle; 3rd joint with 1 dorsal and 1 ventral bristle and without suture separating it from 4th joint; 4th joint with 1 dorsal bristle and 2 long and 1 short ventral bristles; 5th joint with stout terminal ventral bristle; 6th-8th joints apparently with normal number of bristles, but difficult to discern because of poor condition of slide.

Brady and Norman (1896, p. 678) reported only 2 ventral bristles on the 4th joint.

Second antenna (fig. 16*b*): exopodite with 9 joints decreasing in width distally; 2nd–8th joints each with 1 long stout bristle; 9th joint with 1 short and 1 long bristle; bristles on 2nd–9th joints without hairs or marginal spines; endopodite 1-jointed with 2 short ringed proximal bristles.

Brady and Norman (1896, p. 678) described the endopodite as a "secondary branch rudimentary, consisting only of a little nodulous

process carrying one short seta." A second spine is clearly discernable on British Museum slide no. 1900–3–6–458.

Mandible (fig. 16*c*): Each joint of endopodite with long curved

FIGURE 16.—*Sarsiella capsula* Norman (slide 1900–3–6–458, British Museum): *a*, 1st antenna; *b*, 2nd antenna; *c*, mandible; *d*, maxilla; *e*, 7th limb; *f*, furca.

claw ventrally. The mandible on each slide is in poor condition permitting discrimination of only gross features. A faint row of short spines borders the ventral margin of the coxale of a mandible mounted

on slide no. 1900–3–6–457 (British Museum) but not on mandibles on slide no. 1900–3–6–458 (British Museum).

Maxilla (fig. 16*d*): 2nd joint of endopodite with 2 slender bristles on outer side, 1 short bristle on inner side, and 5 stout terminal bristles with marginal spines.

The maxilla was the only appendage illustrated by Brady and Norman (1896, pl. 9: fig. 18). It is essentially the same as the maxilla on slide no. 1900–3–6–458 (British Museum) illustrated in this paper (fig. 16*d*).

Seventh limb (fig. 16*e*): 6 bristles in terminal group; 2 bristles in proximal group; all bristles with 2–4 distal bells.

The distal tip of the 7th appendage can not be observed clearly on British Museum slides (1900–3–6–457; 1900–3–6–458). This limb was not described by Brady and Norman (1896).

Furca (fig. 16*f*): each lamella with 5 curved claws decreasing in length posteriorly; claw no. 1 joined to lamella; claws 1–3 with lateral and medial spines in row along concave margin.

Brady and Norman (1896, p. 678) described the furca as having 6 claws. In both British Museum slides (1900–3–6–457; 1900–3–6–458) the furca is compressed, making the claws difficult to distinguish; however, only 5 claws can be observed on each lamella.

Sarsiella disparalis Darby

FIGURES 17–19; PLATE 4

Sarsiella disparalis Darby, 1965, p. 40, pls. 30, 31.

Holotype: Museum of Paleontology, University of Michigan, 48819, female.

Darby (1965, p. 40) described *S. disparalis* based on 5 females collected off Sapelo Island, Ga. The shells of his specimens varied considerably in ornamentation, some weakly and others strongly ornamented, or the right valve ornamented and the left valve almost plain. I received 2 mature females of this unusual species, both with asymmetrical shells, in a collection from the Atlantic shelf off Beaufort, N.C. To determine whether the asymmetry and variability of the shells might be caused by parasitism, both specimens were examined for parasites, but none were found. Left and right appendages were compared to determine if asymmetry in valves was reflected in them, but differences were found to be minor. Examination of a slide (UMMP 48818, no. 86) of a paratype prepared by Darby revealed the presence of a parasitic copepod of the family Choniostomatidae, but it is not considered likely that it is the cause of shell asymmetry in *S. disparalis* because the specimen containing the copepod is fairly symmetrical. Both the holotype and the above-mentioned paratype were examined.

MATERIAL.—Collection data on the specimens is as follows:

USNM number	sta. no.	no. of specimens	latitude-longitude	date collected	depth (m)	type bottom	sediment temp. (° C)	sampler type
113470	92	1	34°34.5′ N–76°25.5′ W	June 24, 1964	19	fine sand and shell	23.0	0.2 m van Veen
113471	158	1	34°22.8′ N–75°52.7′ W	Sept. 30, 1965	200	sandy mud	21.0	15 min. dredge

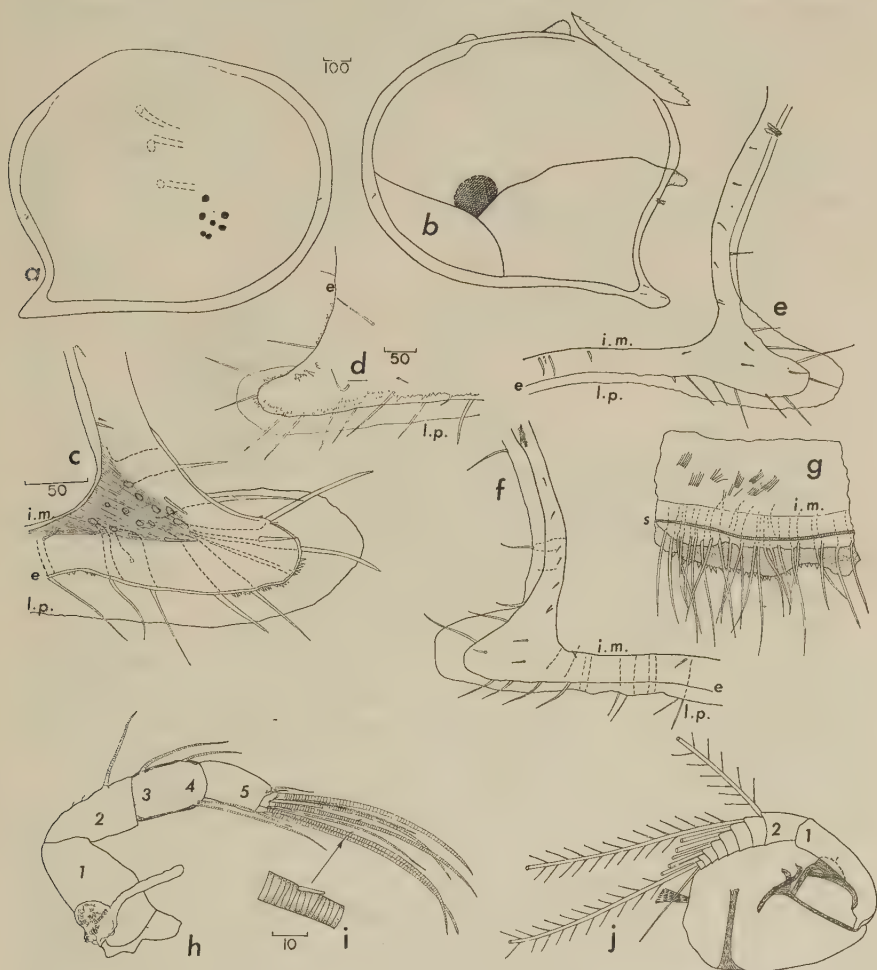

FIGURE 17.—*Sarsiella disparalis* Darby, sta. 92, ♀, 1.50 mm: *a*, medial view left valve; *b*, medial view right valve (cross-hatching indicates area of adductor muscle attachments). Caudal process right valve: *c*, medial view; *d*, lateral view. Medial view of posterior and caudal process of valves: *e*, right valve; *f*, left valve. Other parts: *g*, margin of right valve showing clusters of spines, medial view; *h*, 1st antenna, frontal organ and medial eye; *i*, enlargement of spine on bristle of 1st antenna; *j*, left 1st antenna. (Same scale in microns: *a, b; c; d-h, j; i.*)

Description of females in collection.—Shell (figs. 17*a-g*; pl. 4): Right valve ornamented, left relatively plain (pl. 4); caudal process directed posteriorly (figs. 17*a*, *b*), with spines and bristles on lateral surface (fig. 17*d*); selvage narrow striated, (fig. 17*g*); lamellar prolongation of selvage with denticulate margin in some areas, becoming wider around caudal process; adductor muscle scars obscure, consisting of several ovoid scars anteriorly and ventrally to midvalve; marginal flange narrow, becoming wider along ventral and posterior margins, with numerous bristles and toothlike spines; false radial pore canals numerous, normal pore canals sparse.

Inner lamella with small bristle anteriorly (figs. 17*a*, *b*), 3 bristles on caudal process (figs. 17*c*, *e*, *f*), 5 bristles near inner margin anterior to caudal process, and, dorsally to caudal process, 6–7 bare bristles followed by 2 hirsute bristles (figs. 17*e*, *f*).

Dimensions of specimens in collection are as follows:

USNM	*maximum length (mm)*	*height (mm) excluding caudal process*	*remarks*
113470	1.50	1.2	♀, 8 eggs in brood chamber
113471	1.43	1.15	♀, 6 " " " "

First antenna (figs. 17*h*, *i*; 19*k*): 1st joint bare; 2nd joint with 1 dorsal bristle and 2 dorsal spines; 3rd joint with 1 dorsal bristle; no suture between 3rd and 4th joints; 4th joint with 1 dorsal and 2 ventral bristles distally; 5th joint with 1 long ventral bristle distally; 6th joint with 1 short medial bristle distally; 7th–8th joints with 1 short and 7 long bristles.

Second antenna (figs. 17*j*, 18*a–c*): exopodite with 9 joints; 1st joint with short, curved terminal spine medially; 2nd–8th joints each with 1 bristle with natatory hairs; 9th joint with 1 long and 1 short bristle, both, or only longer bristle, with natatory hairs; distal lateral margins of 3rd–8th joints may have 2 or more small spines; endopodite 1-jointed, with 2 proximal bristles and 1 short, unringed ventral bristle.

The endopodite of the right 2nd antenna of USNM 113471 differs from the left and also from USNM 113470 in having only 1 proximal bristle. The 8th and 9th joints on the exopodite of the right 2nd antenna on USNM 113470 are abnormal in being fused and in having the long bristle on each joined together, forming a single forked bristle (fig. 18*c*). The short bristle on the 9th joint of each exopodite on USNM 113471 is shorter than the equivalent bristle on USNM 113470.

Mandible (figs. 18*d–i*): coxale with ventral fringe of short spines and short ringed medial spine (spine not observed on right mandible of specimen 113470); basale with 3 spinelike bristles dorsally and 1 lateral and 4–5 medial bristles ventrally; endopodite 3-jointed; 1st

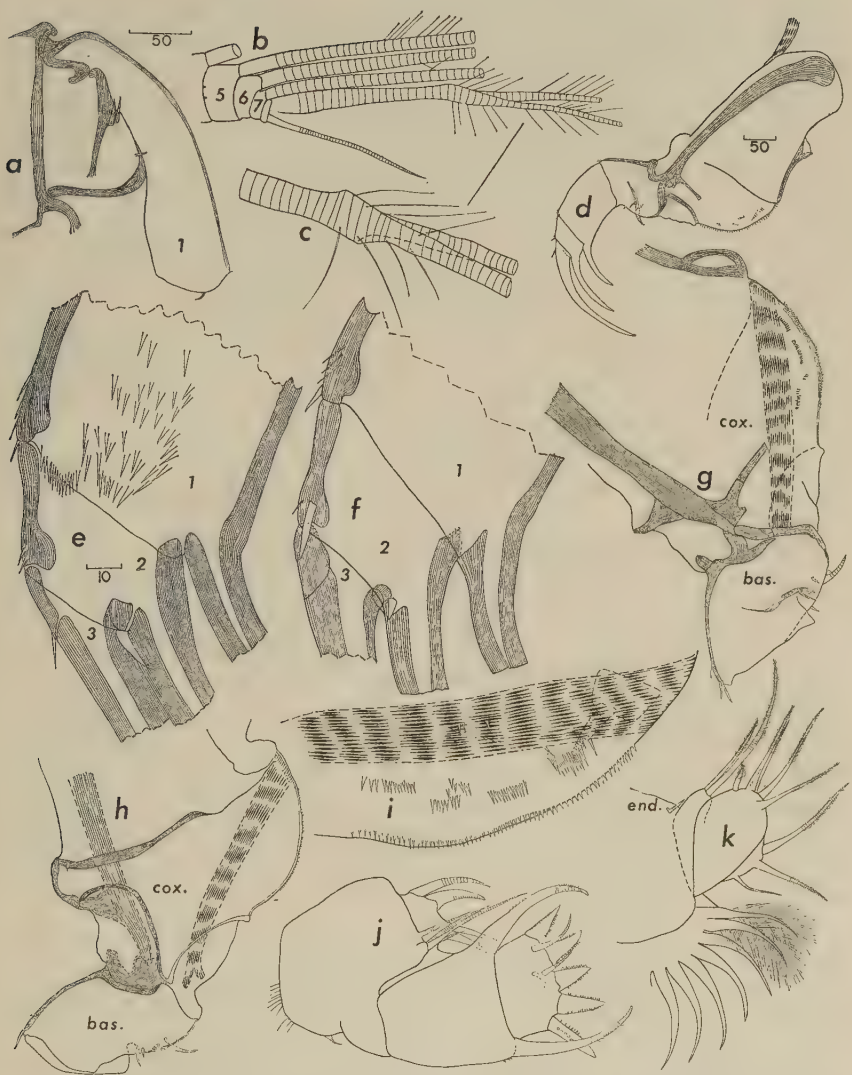

FIGURE 18.—*Sarsiella disparalis* Darby, sta. 92, ♀, 1.50 mm: *a*, left 2nd antenna, endopodite and 1st joint of exopodite; *b*, right 2nd antenna, end joints of exopodite; *c*, right 2nd antenna, abnormal combined bristles of 8th and 9th joints. Mandible: *d*, left appendage; *e*, right endopodite; *f*, left endopodite; *g*, left coxale and basale; *h*, right coxale and basale; *i*, enlargement of ventral part of left coxale, lateral view. Other parts: *j*, left maxilla, lateral view; *k*, left 5th limb. (Same scale in microns: *a, b, g, h, j, k; d; c, e, f, i.*)

joint with large curved terminal claw, 3 dorsal spines, and numerous spines medially (fig. 18*e*), 2nd joint with large terminal claw and 1 long and 1 short spine dorsally, 3rd joint with large curved terminal claw and 1 short spine dorsally and 1 ventrally.

Maxilla (figs. 18*j*, 19*k*): protopodite with short bristle on anterior margin and fringe of marginal hairs; basale with bare bristle near exopodite; exopodite with 1 long and 2 short bristles; 1st endopodite joint with 2 stout curved bristles with marginal spines, bristles annulate distally; end joint with 5 stout pectinate bristles, 2 slender lateral bristles and 1 short medial bristle; 1st endite with about 6 bristles, 2nd endite with about 5 bristles, 3rd endite with 4 bristles.

Fifth limb (fig. 18*k*): endite with 1 bare bristle; exopodite: 1st joint with 2 bristles with short spines, 2nd–5th joints with marginal hairs and total of 7 bristles, 6 with marginal spines, 1 bare, joint sutures indistinct; epipodial appendage with about 36 bristles.

Sixth limb (fig. 19*a*): endite with 1 long and 2 short bristles, ventral margin of end joint with 10 spinous bristles followed by 2 hirsute posterior bristles.

Seventh limb (figs. 19*b*, *c*): cleaning bristles: 6 terminal, 4–5 proximal, each with 3–8 bells; terminal comb with 8–14 teeth on each side.

Furca (figs. 19*d–f*): each lamella with 5 curved and pointed claws; claw 1 joined to lamella, remaining claws separated from lamella by suture; claws decrease in length proximally on lamella; posterior margins of claws 1–4 with lateral and medial teeth in rows; distal end of anterior margin of 5th tooth on left lamella with small tooth or spine; ventral margin of lamella, posterior to 5th claw, with 2–3 spines on left lamella and 1 spine on right lamella; medial surface of left lamella, between claws 4 and 5, with small spine; margins of lamellae without hairs; anterior part of ostracod body, proximal to furca, spinous (figs. 19*d*, *g*).

Frontal organ (figs. 17*h*; 19*h*, *k*): 2-jointed with short 1st joint and elongate 2nd joint, with rounded tip.

Genitalia (fig. 19*j*): genitalia with 2 large vaginal openings beneath 5 minute ringed bristles.

Eyes: median eye large, pigmented (figs. 17*h*; 19*h*, *k*); lateral eyes small, pigmented, with about 6 ommatophores around edge (figs. 19*i*, *k*).

Upper lip (fig. 19*k*): triangular process present between upper lip and basis of 1st antenna.

Eggs (fig. 19*l*): each egg surrounded by transparent membrane and containing numerous small oil globules; 6–8 eggs occupying brood chamber between posterior lobes of valves.

Ecology.—Depth: One specimen from the North Carolina shelf was collected from a depth of 19 m, the second from 200 m. Darby

(1965) collected specimens in water 12.5–18.6 m deep on the Georgia shelf; the known depth range, therefore, is 12.5–200 m.

Temperature and salinity: Temperature of the sediment on the North Carolina shelf was 23°C at 19 m and 21°C at 200 m (Day,

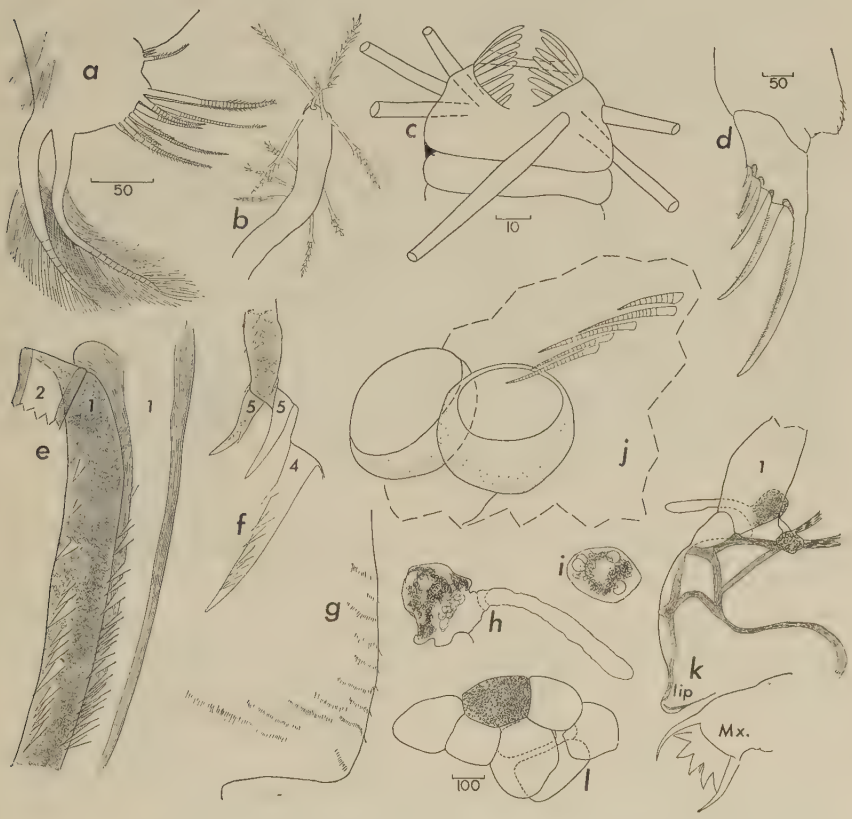

FIGURE 19.—*Sarsiella disparalis* Darby, ♀: *a*, right 6th limb, lateral view; *b*, 7th limb; *c*, enlargement of terminal process on 7th limb; *d*, furca, lateral view right lamella; *e*, furca, enlargement of claw no. 1 showing distribution of teeth (left lamella stippled); *f*, furca, enlargement of claws 4, 5 (left lamella stippled); *g*, enlargement of part of anterior surface above furcal attachment shown in *d* above; *h*, frontal organ and medial eye; *i*, lateral eye; *j*, genitalia; *k*, anterior of ostracod showing medial eye, frontal organ, 1st joint of 1st antenna, lateral eye, upper lip, maxilla; *l*, group of 8 eggs from brood chamber. (Figs. *a-i*, *k*, *l* from sta. 92, 1.50 mm; fig. *j* from sta. 158, 1.43 mm. Same scale in microns: *a*, *h*, *i*; *b*, *d*, *k*; *c*, *e-g*, *j*; *l*.)

in litt.). It is probable that the salinity was 35–36 parts per thousand at 200 m depth, where a specimen was collected on the North Carolina shelf. Darby (1965, p. 40) reported the salinity in the area he collected *S. disparalis* to be about 25 parts per thousand.

Substrate: The specimen from 19 m on the North Carolina shelf

was collected in a sediment consisting of fine sand and shell; the specimen from 200 m was collected in sandy mud.

Food: The specimen from 200 m depth on the North Carolina shelf contained in its stomach a large, whole harpacticoid copepod, several arthropod appendages, and a diatom. One of Darby's specimens (UMMP 48819) examined by me contains 2 free-living nematodes in the stomach: 1 appears to be partly digested, and the good condition of the other suggests that it had been ingested only prior to capture of the ostracod.

Parasites: No parasites were observed on the 2 specimens from the North Carolina shelf. One of Darby's specimens from off Georgia, however, contained in the brood chamber a parasitic female copepod of the family Choniostomatidae along with several clusters of copepod eggs. The slide (UMMP 48818, no. 86) containing the copepod and copepod eggs is labeled "Eggs" by Darby, who apparently thought them to be ostracod eggs. The shell of the specimen containing the parasite is quite symmetrical indicating that the parasitic copepod is not the cause of some specimens of *S. disparalis* having asymmetrical shells.

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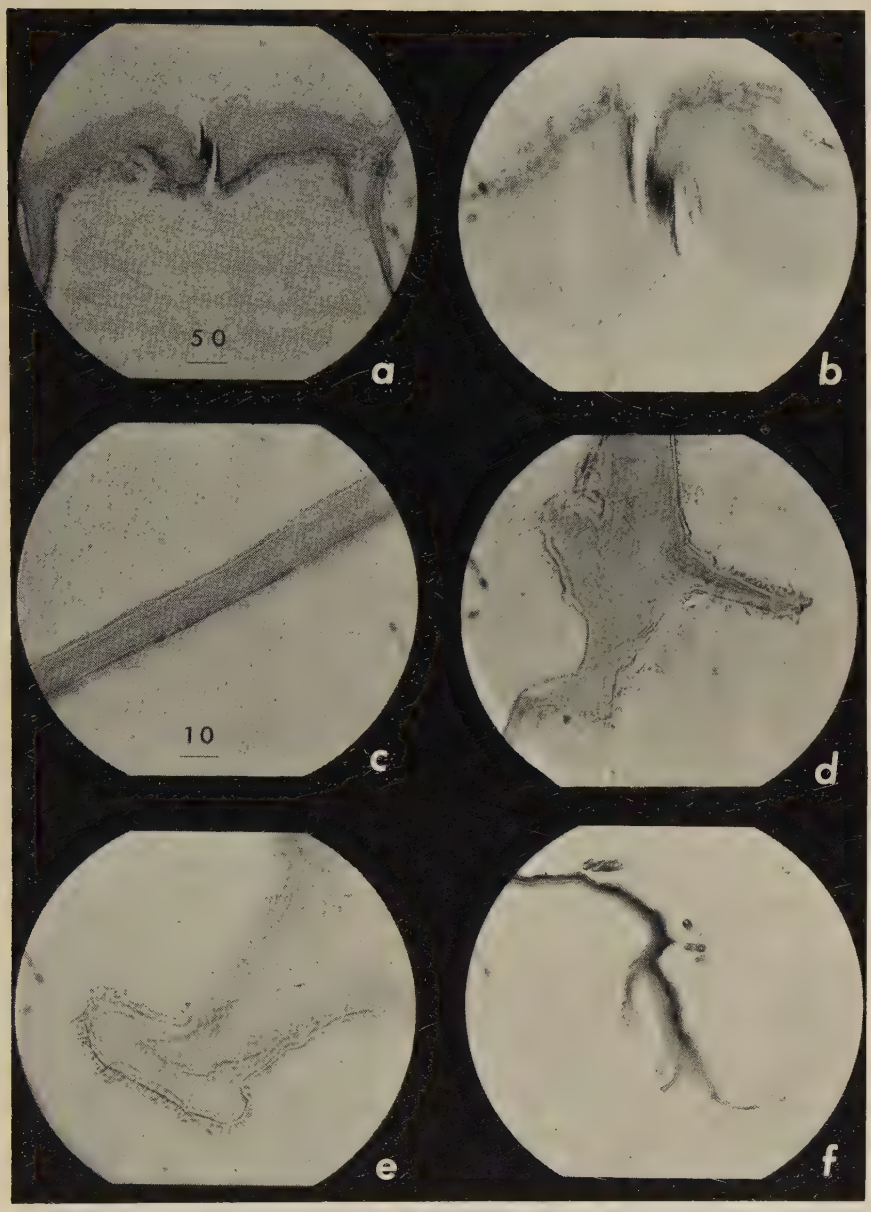
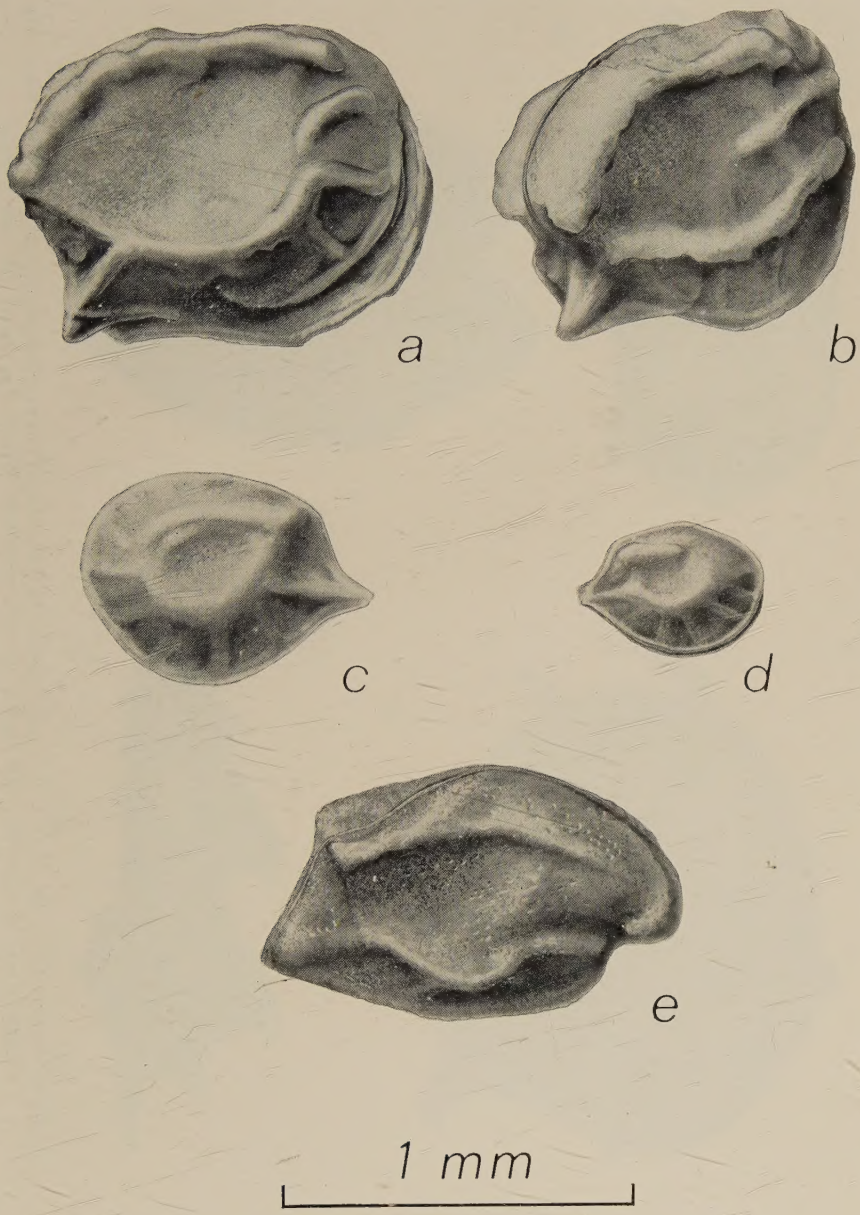
Plates

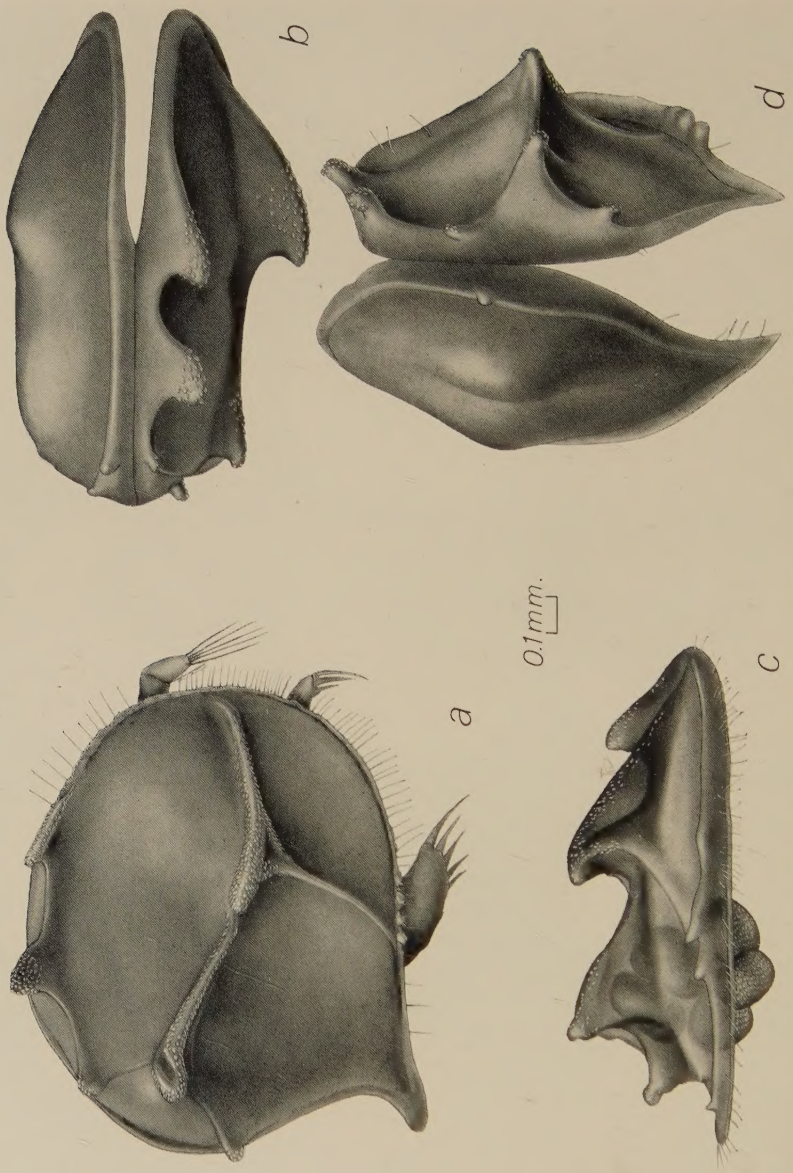


Sarsiella zostericola Cushman, transverse sections through shell: *a*, dorsal, through hinge and ligament; *b*, enlargement of ligament in *a*; *c*, outer lamella showing lineations, inner side of lamella is toward bottom of illustration; *d*, ventral margin, left valve; *e*, middle ridge; *f*, ventral margin right valve showing selvage, false marginal pore canal with bristle, marginal ridge. (Same scale in microns: *a*, *f*; *b*–*e*.)

Sarsiella zostericola Cushman, stage V ♀: *a*, proximal part of 1st antenna, frontal organ with medial eye, lateral eye; *b*, furca and genitalia; *c*, enlargement of genitalia in *b*; *d*, eggs in ovaries. Stage V ♂: *e*, 1st and 2nd antenna, mandible; *f*, 1st antenna, 2nd–8th joints; *g*, 2nd antenna; *h*, 2nd antenna, endopodite, and proximal part of exopodite; *i*, mandible; *j*, maxilla; *k*, maxilla, oblique view; *l*, 5th limb, distal part; *m*, 6th limb; *n*, furca and copulatory organ; *o*, frontal organ and medial eye. (Same scale in microns: *a*, *c*, *d*, *f*, *h*; *j–o*; *b*, *e*, *g*, *i*.)



Sarsiella capsula Norman, slide 1911.11.8, M 3985, British Museum: *a*, *b*, adult females *c*, *d*, juveniles. Slide 1911.11.8, M 3989, British Museum: *e*, adult male.



Sarsiella disparalis Darby, sta. 92, ♀, 1.50 mm: *a*, right lateral view; *b*, dorsal view, valves slightly open; *c*, ventral view, from slightly to rear, of right valve with eggs; *d*, posterior view, from slightly above, with valve partly open.